

NOTE ON IRRIGATION
IN
RAJPUTANA:

A BRIEF SUMMARY OF THE INVESTIGATIONS

MADE DURING 1903-05,

WITH

SUGGESTIONS BY THE CONSULTING ENGINEER.

1905.

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NOTE ON IRRIGATION IN RAJPUTANA,

1903-1905.

1. This brief summary of the investigations made during 1903-1905 is intended to place on record the history of the subject—how the question originated, the views of the Government of India and its efforts to help the Native States of Rajputana in the matter of Irrigation; to take stock of local conditions, and to ascertain which are the most promising schemes, primarily with a view to prevent money being wasted, as in the last famine, upon unsuitable or ill-considered works, and to ensure that what is spent in future is spent to the best advantage.

Brief Summary.

It shows how these views have been carried out; the present condition of each of the Native States, 18 in all, including the Chiefship of Shahpura; the measures proposed; some of the causes which retard Irrigation, and suggestions to improve it.

It does not pretend to be a professional paper or to deal with all the many Engineering questions, but merely to state, in one pamphlet, facts and suggestions, the results of experience, which may prove of interest or of use to others.

For further details reference can be made to the Reports on Irrigation and for each Project, which have been printed separately for each State. A brief extract of each will be found in the Appendix under the head of each State.

A perusal of the Index will show the scope of this pamphlet.

2. In November 1901 the Irrigation Commission visited Rajputana and recommended that Mr. Manners Smith should be retained on special duty, in order to complete certain Projects for Irrigation in Rajputana.

Irrigation Commission visit Rajputana. Results.

The Commission advised a general hydrographical reconnaissance of Rajputana as a whole, and considered it so important that no time should be lost that they addressed the Government of India at once on the subject, in the letter marginally quoted. (Appendix A.)

To the Government of India in the Revenue and Agriculture Dept., No. 239, dated 13th February 1902.

3. They pointed out that it is impossible to protect Rajputana completely against famine; that this renders it all the more important to utilise to the utmost such means of protection as exist; that a large

Impossible to protect Rajputana completely.

body of water annually runs useless through this exceedingly insecure area to the sea; and that the problem to be attacked is, to reduce this waste of water to a minimum. Its utilisation to be effected by means of dams and storage tanks, as there are no perennial streams in Rajputana, and in many parts the wells are themselves largely dependent upon percolation from storage for their supply of water.

That at present the capabilities of the country for the storage of water are not known, nor the manner in which they can be best made use of, and that the first thing necessary is to collect and record this information.

No water
to go to
waste.

4. That although something had been done where a Native State had employed a competent Engineer, and in those Native States where there was no Engineer Officer the Supreme Government had lent the services of a qualified Officer (Mr. Manners Smith), who had been employed for some months past to examine and prepare the schemes, which upon a cursory examination appeared to be the most promising, yet much more than this was desirable if the maxim that it is wrong to allow a drop of water to go to waste in Rajputana is to be acted up to.

Systematic
examina-
tion of
each catch-
ment
necessary.

5. What was wanted was a systematic examination of Rajputana as a whole, based upon its physical rather than upon its political divisions. That each catchment should be taken up in turn and an Irrigation reconnaissance made from its head downwards, to discover where dams can best be placed or water stored, and the more detailed surveys upon which plans and estimates would be based, would follow in due course, though all of them need not be undertaken at once. That it will be sufficient to keep always in readiness such detailed schemes as will afford an ample programme for relief should famine again occur.

The oppor-
tunity now.

6. That the recent famine in Rajputana had conveyed a terrible lesson, that the Chiefs and people were apparently anxious to protect themselves against the recurrence of such a calamity. That such a favourable opportunity for systematic and sustained action might perhaps not occur again. That the Commission believed most, if not all, the Chiefs would join in the scheme for a systematic survey, and if nothing was done now we should probably have to wait for another famine before anything was done.

Recom-
mend en-
courage-
ment.

7. That although almost all the Native States in Rajputana were in financial straits, the general survey and even the preparation of Plans and Estimates commits them to nothing; that some even now were stated to be ready to borrow for the purpose of taking up some of the most promising schemes if the Government of India would lend the money; and the Commission strongly recommended that all reasonable encouragement should be afforded in this direction. That in any case the existence of these Projects would ensure relief labour being employed to the best advantage. All that is possible will have been done to help the States, and they will know what is feasible.

8. In order to give practical effect to the above the Commission suggested :—

Suggestions
of the
Commission.

- (a) That where a State already entertained a competent Engineer he would conduct the survey and prepare the necessary Plans and Estimates.
- (b) That in the other States the Government Engineer (Mr. F. St.-G. Manners Smith), already employed in completing Irrigation Projects, should be retained for this purpose.
- (c) That a "Consulting Engineer for Irrigation in Rajputana" should be appointed, who would assist and advise all the Engineer Officers, and would practically direct the whole survey.
- (d) That Colonel Jacob of Jaipur, for the reasons stated by the Commission, should be asked to accept this post.
- (e) That time, labour and money have often been wasted, owing to Surveys and Plans having been lost; for this reason the Commission recommended that all Irrigation Surveys and Projects should be printed.

9. H. H. the Maharaja of Jaipur having consented to relinquish Col. Jacob's services for a time, and the Government having sanctioned the terms on which he was willing to accept the duty of Consulting Engineer for Irrigation in Rajputana, he was appointed to the post. Work was begun on 1st November 1902, though owing to the great Durbar at Delhi, with the exception of a tour in the Dholpur State, it was not till February that it could be taken up in earnest.

Programme
proposed.

The programme proposed was: the first season to be employed in making a tour of inspection with the local officials in each State to ascertain their wishes, to gain their co-operation, and to get from them all the information and help possible, so as to be able to form some idea of the works which may be taken up and of the number of survey parties that can be profitably employed in preparing Projects, furnishing the data required, and to secure good native surveyors.

Before the end of the first season the men would be told what to do; and it was hoped that by the following cold weather the Plans and Surveys of many important works would be ready.

The Consulting Engineer would visit every place where his advice was desired, and would submit a Report afterwards on each State.

Any future action would then rest with the Government of India and the States concerned.

Such was the programme, and the Report now submitted will show how far it has been carried out.

Circular
letter intelli-
gizing
action pro-
posed and
inviting
co-opera-
tion.

10. The first step taken by the Consulting Engineer, with the approval of the Agent to the Governor-General in Rajputana, was to address a circular letter to the Political Agent of each State, pointing out (Appendix B)—

- (1) the interest taken by the Government of India in Irrigation, shown by appointing a Commission to collect information ;
- (2) the promptness with which the recommendations made by the Commission have been acted upon, Government appointing special officers to supervise the investigations in Rajputana ;
- (3) the liberality with which the Government of India have acted, in undertaking to defray the initial cost of the investigations ;

showing clearly that the Government of India were determined to do all that can be done to help the Native States in Rajputana.

That the officer who had been appointed Consulting Engineer was one who was well known in Rajputana, and with the hope of being able to help in the great object which the Government had in view, *viz.*, the welfare of the States in Rajputana, he had given up his intention to retire.

The Agent Governor-General expressed his assurance that these disinterested efforts of the Government of India would be responded to in the same spirit by the Rulers of the Native States concerned.

It was pointed out that there were three stages of operations—

- (1) The investigation of each catchment area, to ascertain the possibilities in the way of Irrigation in each State, for which no detailed surveys were necessary.
- (2) The inspection by the Consulting Engineer for Irrigation of all such proposals, to give advice where required.
- (3) The preparation of proper Plans and Estimates for a certain number of approved Projects in each State.

That at present it was only desired to direct attention to the first stage; that this investigation should be taken up by the Local Engineer Officers in real earnest, so as to be able to place sufficient data before the Consulting Engineer, to enable him to give advice on any proposal.

It was pointed out that in some of the States, Irrigation had not been taken up with the energy and spirit that its importance deserves ; that not a drop of water which could be stored and made use of should be allowed to go to waste ; and that it was only by the cordial co-operation of each Durbar and the Local Engineers and officials that anything can be done to secure this great object.

The Political Officers were asked to give copies of the letter noted (see Appendix B) to all concerned, with the hope that no time would be lost, as the work was urgent.

It was expressly stated that no scheme would be begun or any expenditure upon it incurred in any State without the concurrence of the Chief.

Difficulties
to be
overcome.

11. The main difficulties to be overcome were :—

- (a) The collection of a reliable staff—always more difficult for temporary employment.
- (b) The necessity for the personal inspection by the Consulting Engineer or the Superintending Engineer of every site, to ascertain local conditions, and to explain on the spot what was to be done.
- (c) The distances which had to be travelled to places often not easily accessible, to find out sites, and often only to be disappointed.
- (d) The organisation and proper supervision of Survey parties in Native States; often in out-of-the-way places; the necessity of doing this without friction, some of the sites being in the lands of Jagirdars, who are naturally jealous of any interference.
- (e) The paucity of population in many places. To ensure the success of any Project, cultivators are necessary to use the water.
- (f) That in some of the States, Irrigation is only really required in years when the rains fail.
- (g) That in some places attempts which have hitherto been made to introduce Irrigation have not realised expectations.
- (h) The financial condition of many of the States, making it hopeless to suggest Projects which they have not the means to carry out.
- (i) The short time available (2 years) to get all the investigations carried out and the Projects prepared and placed on record.

12. In the original scheme it was proposed that the Imperial Government should bear the initial cost of these investigations, and if eventually any scheme is carried out, the initial expenses incurred by the Imperial Government might then be recovered as a first charge on the revenue derived.

Expenses
to be
borne by
the
Imperial
Govern-
ment.

This appears to have caused apprehension in some quarters. There was a suspicion that by joining in this scheme, a State might be letting itself in for unknown liabilities, and to properly apportion the expenditure presented great difficulties. This was represented to Government, and the Consulting Engineer's recommendation that the whole of the charges should be borne by Government, and that the States should be informed that no refund of these preliminary investigations would be required from them, was strongly supported by the Agent to the Governor-General.

The Imperial Government undertake to bear the whole cost.

No. 4420 I. A., dated 24th Sept. 1903, from the Government of India in the Foreign Department, to the Agent Governor-General, Rajputana.

13. The Government of India considered that although these investigations were intended to benefit directly the Native States, and under ordinary circumstances would not be sufficient to justify the Government in throwing the cost upon the British Indian tax-payer, yet, taking everything into consideration, it was decided there was just reason for the paramount Power to treat the Native States in a generous spirit, and accordingly the Agent Governor-General was authorised to inform all concerned that as a very special case it had been finally decided to relieve the States and Chiefships of all charges connected with these preliminary investigations. (See Appendix C.)

The care taken to remove all apprehensions.

Letter No. 3409 I. A., dated 14th September 1904.

14. Lest any of the Native States might entertain any fears that they would be pressed unduly to spend money on works which were shown to be feasible, the letter marginally noted from the Government of India in the Foreign Department was addressed to the Agent to the Governor-General in Rajputana in September 1904. (See Appendix C.)

It was pointed out that the immediate object of these investigations was to ascertain which are the most promising schemes, primarily with a view to prevent money being wasted as in the last famine, and to ensure that what is spent on relief works in future may be spent to the best advantage.

That the reconnaissance which had been completed in many of the States was only preliminary, and until proper Plans and Estimates have been prepared, the schemes are not available for famine or any other purpose.

It was desired that Plans and Estimates should now be prepared, and when the financial condition of any State permits, encouragement should be given to carry out works which are shown to be feasible and to have a protective or a productive value.

It was anticipated that one of the strongest objections which the Durbars might have to the hydrographic investigation of Rajputana suggested by the Irrigation Commission, would arise from the fear that they would be pressed to spend money upon the works which are shown to be feasible; and although care was taken to point out that this was not intended, yet if any of the Durbars still had fears on this point, an early opportunity should be taken to dissipate this suspicion.

The Survey is not yet complete, and if one Durbar sees another pressed, as it believes, to spend money on these schemes against its will, opposition and obstruction may be aroused, which may do far more harm in the end than the mere postponement of a few protective works.

The above shows how generously and considerately the Government of India have acted throughout towards the Native States of Rajputana. Every State visited.

15. Rajputana comprises an area more than twice that of England and Wales, made up by 18 different Native States, *viz.*, Alwar, Banswara, Bikaner, Bundi, Dholpur, Dungarpur, Jaipur, Jaisalmer, Jhalawar, Jodhpur, Karauli, Kishangarh, Kotah, Mewar or Udaipur, Pertabgarh, Sirohi, and Tonk, and the Chiefship of Shahpura. In these investigations every State in Rajputana has been visited by the Consulting Engineer, except Karauli and Jaisalmer, for the reasons stated further on ; and every State without an Engineer Officer has been thoroughly investigated by the Superintending Engineer (Mr. Manners Smith), and a printed Report has been prepared showing the present condition and what is suggested might be done to promote Irrigation in each State.

Rajputana needs water perhaps as much as any part of India, for it depends almost entirely upon the monsoon rains for its water supply. Advantage has been taken here and there to store some of this flood water in some States in a small way for Irrigation, but hitherto no attempt has been made to deal with the immense volumes of water which goes to waste in some of the largest rivers ; partly, perhaps, because of political difficulties, as the large rivers generally flow through two or more States ; partly for want of data ; and because it is beyond the power of any one State to initiate any large scheme, or to combine for such an object, and is beyond their means to carry out. The Imperial Government only is able to do this.

The officers who have been entrusted with these investigations naturally turned to see if anything could be done with the two largest rivers in Rajputana, *viz.*, the Chambal and the Banas, with their unfailing supply of water.

Regarding the Chambal, nothing appears to be possible, for the reasons stated in the Report on the Kotah State, pages 5 and 6.

Regarding the Banas, a good site for a Storage Reservoir was found, and a Project has been prepared, which is described further on (under the allusion to the Mewar State). It would be difficult to find a better Irrigation Project of this magnitude in Rajputana. The Report with Plans and Estimate have been submitted to the Government of India.

16. In the States which have no Engineer Officer, nearly every catchment area has been thoroughly investigated by Mr. Manners Smith, Superintending Engineer. Many Projects have been carefully worked out under his supervision, and have been printed and placed on record. Some are of considerable magnitude, beyond the initiative and the power of the States themselves, perhaps, to carry out unaided ; still it is a great thing to have such possibilities brought to notice and to be shown how to deal with them.

States without Engineer Officers. Projects prepared. Work done is of a permanent character.

The work which has been done, too, is more or less of a permanent character. Bench marks have been put up and Plans and Estimates printed and placed on record, so as to be available at any time. The Chiefs and people can hardly fail to see that this has all been done entirely for their benefit, without costing them anything; and it must help to prove that the Imperial Government believes in the importance of Irrigation and the benefits of storing water. All this has attracted attention, and it is hoped will awaken a more lively interest in the subject than has hitherto prevailed.

Expenditure incurred.

The Imperial Government could not have done more for Rajputana so far, or have done it in a more generous spirit. The total expenditure which has been incurred in these investigations up to the 31st March 1905 is about Rs. 1,78,426. (Appendix F.)

If anyone is disposed to find fault with the Government of India for not doing more to promote Irrigation, we would suggest a perusal of this Report.

Statements of the work done.

17. The Statements (Appendices D and E) show briefly the work which has been done; they do not show all the places visited, but only those approved. The work has all been done not only without friction or complaint, but with the goodwill of all concerned.

It is too soon, perhaps, to expect to see results, but proof has been given, in the Mewar State for instance, that the Udaipur Durbar have already adopted some of the suggestions made; and in other quarters that other States are waking up.

Brief Summary from the Report on each State.

18. The printed Reports which have been prepared and submitted for each State show in detail the results of these investigations, the present condition of each State, and what might be done. It is impossible in a brief summary like this to do more than give a general idea of the country and conditions we have to deal with, and to indicate the salient points of interest; but it may be convenient to have these at hand in this shape. A knowledge has been gained of the conditions and requirements of every part of Rajputana. Interest has been awakened all round in Irrigation. Information has been diffused as to the ways of dealing with water and the benefits which have been realised in other places, and suggestions made of a practical kind which every State can follow.

Different points from which Irrigation has been considered.

19. In all these investigations, the endeavour has been made to consider Irrigation from every point of view, but chiefly for the storage of the immense volumes of water which now annually go to waste; for example, by—

(a) Storage Tanks on watercourses.

(b) Storage Tanks for surface drainage, supplemented, if possible, by cuts from any watercourse near.

- (c) Weirs to divert water in flood to places where it can be stored, or to inundate the land ; or to hold up pools from which, after the rains, water can be raised by lift of some kind to fields adjacent.
- (d) Shallow tanks, or field embankments, to retain water for a short time only, when it can be run-off to give one watering to lands below, and the bed can be cultivated.
- (e) By wells of masonry (ordinary or deep) or by kutchha wells.
- (f) By inundation canals.
- (g) By repairs to existing works or improvements to them, or to the ducts from them.

And to suggest measures which are simple and practicable, suited to the conditions of each State.

20. The printed Reports show what has been proposed for each State, according to the conditions most suitable to each place.

It is true it may not be possible, perhaps, to carry out all these Projects for some time. Still it has been clearly pointed out to each Native State and to all concerned, the general lines on which to work, and what are considered the best Projects to take up; so that no delay or uncertainty or waste of money ought to occur in future.

21. There is an idea generally prevalent that by the construction of numerous tanks the country may eventually be protected from the worst effects of famine, but it is questionable if this is a correct one. Tanks.

The real benefit of tanks is that when the rainfall is deficient, or is so irregularly distributed as not to be capable of bringing crops to maturity, the water stored will be able to supplement it, and to permit of the growth of crops. There are many more years of deficient and irregular rainfall than there are of total scarcity, and it is during these former years that tanks will be of substantial benefit and will fully justify their construction.

The failure of the largest tanks constructed in the plains may be expected in years of great deficiency of rainfall. It is therefore desirable that sites in the hills or connected with large nullahs should be utilised first, as they are likely to fill better and so be productive of most good.

Small tanks are of little use in a famine or year of deficient rainfall ; still they will utilise small catchments which might otherwise be wasted and will provide for the irrigation of isolated areas which might not otherwise be developed.

The advantage of even small tanks in benefiting village wells by percolation is well understood by the natives. They often made requests for small tanks with this object.

In Dungarpur the influence of small tanks was everywhere apparent ; for in ordinary years sugarcane even is grown below them, and is matured without extra watering ; the soil is so retentive of moisture in the hollow places between the rocky hill, that rice is often grown without extra watering, and gram afterwards in years of good rainfall.

Large tanks, on the other hand, will have larger and more unfailing catchments; will be capable of irrigating larger areas, which will affect the productive capacity of the country as a whole; their rate of storage will be cheaper ; their maintenance will be comparatively cheap and their supervision easy, and they will help to store the supply of good years to make up for the deficiency of bad years.

Large Projects need larger initial expenditure, yet it is from them that protection from famine can best be expected, and provided there are sufficient cultivators they will give the best returns.

22. To be an efficient protective work against famine and to secure good results the following conditions are necessary :—

A good basin for storage ; a good catchment area ; a good site for the dam and for the escape ; an unfailing supply of water available at the proper time ; a large area of good land commanded ; cultivators able and willing to make good use of the water ; and good supervision afterwards.

The canal and distributaries should be designed so as to ensure enough water being available for the irrigation of all land which will take it, within the time limit for the first watering. It is no good to offer water when it is too late to use it. The distribution of water should be prompt, plentiful, and assured ; if it is not so, cultivators lose confidence.

Last, but not least, to ensure success there must be an intelligent interest in the subject by those in authority.

This is one of the most important points. Before any real progress can be expected, a real personal interest must be shown in the subject by those in charge of the administration of a State, whether European or Native. Where this is wanting it is often due to a person not having seen the results of successful schemes, or to the fact that Projects have sometimes been carried out which do not fulfil expectations, and thus destroy confidence. Great care and discrimination are necessary, lest by ill-digested schemes progress is retarded

Anyone who has seen the results of successful Irrigation, and how thoroughly it is appreciated by the people, would never hesitate a moment in carrying out a good Project. Money cannot be spent in a better way.

It is important to keep down capital cost as much as possible without sacrificing efficiency ; but even where a scheme is not expected to bring in much direct profit, it may be of great value in other ways.

Conditions
necessary
to secure
success.

In the Jaipur State it is found that where water can be stored at the rate of 3,000 c.ft. for a rupee, other conditions being favourable, the Project ought to be able to bring in a good return on the original cost.

23. In regard to mitigating the effects of scarcity, the proper programme seems to be to construct, in the first instance, large tanks with unfailing catchments, then those with less certain ones, and finally small ones for the benefit of isolated areas.*

It is doubtful if at first Tank Irrigation will be remunerative, owing to the low rates charged in India for irrigation and to the great loss by evaporation; but with proper arrangements the result will improve.

The Programme to follow.

The benefit to the country as a whole has to be taken into account. If an Irrigation work pays a little more than its working expenses during normal periods, it may be accepted as a scheme financially sound in regard to the country as a whole, although far from being directly remunerative.

It is useless to expect from Tank Irrigation the returns derived from the large canals which are supplied by great perennial rivers and do not require expensive storage works.

The proper way of regarding tank schemes is to remember that they are the only ones available for the lands they serve, and that it is the duty of those in authority to develop the country so far as the finances will permit.

24. The construction of tanks affords the most suitable work for famine labour. If expenditure on relief during times of famine is devoted to the construction of such works, instead of being incurred on works of only temporary utility, each successive famine will thus permanently enrich the country and render it better able to withstand future scarcity.

It is of course necessary that a well-considered programme of work should be arranged before a famine has to be dealt with. It is for this reason the Government of India have come forward so generously to help the Native States of Rajputana.

25. It may help some who wish to make bunds to have a few suggestions. As regards the materials of which bunds may be made, this will depend upon the site and materials available, and sometimes on the comparative cost.

Materials for Dams.

Wherever rock is on the surface or near it, masonry or concrete should be used, or where the earth is not to be trusted from any cause or there is a fear of animals making holes. The masonry or concrete may be used either as a core-wall or as a face-wall, or the dam may be entirely of masonry. Types of each of these will be found among the schemes proposed.

* Indian Storage Reservoirs. By W. L. Strange. Page 46.

Earth or
Sand Dams.

26. Earthen bunds as a rule can be made of any size, and often admit of being enlarged afterwards. The greatest care, however, is necessary that no clods are allowed in the construction nor holes of any kind afterward. Sand if it can be protected from being blown away, or from weeping away in the rear slope, is not a bad material. Sand dams have been built in the Jaipur State and have answered; one was 61 ft. high and 400 ft. thick at the base, and has had 32 ft. of water against it. Another is 90 ft. high and 600 ft. thick at the base, and has had 53 ft. of water against it. In the latter instance a core-wall of *morinda* (clay and sand) was put in the bank, 20 ft. thick at the ground line.

When there is any doubt a core-wall of some kind should be used, and if rock or good hard soil is near, should be taken down into it; or if these or not to be found, then to a depth equal to half the depth of water against it.

If leakage occurs, which probably will in cases where the core-wall is not on rock, measures must be taken at the toe of the outer slope, by putting gravel next to the sand, then broken stone and then larger rubble, to drain off the leakage without letting it saturate the bund. Leakage can often be utilised lower down by a lift or by natural flow.

If it is not found possible to make use of the leakage, it may be better to divert the water from the nullah to some place on the open country, where it can be stored without disappearing so rapidly.

Leakage
near Hills.

27. There is always danger of leakage in any tank made near a range of hills. It may be suspected in some places from the angle and strata of the rocks, but it is often impossible to say beforehand.

In such cases, if there are no other tanks near to guide one, it is advisable to begin with a small work and not to spend much money straight off.

This has been experienced in the Jaipur State and in the Kotah State and at Pindwara in the Sirohi State.

These remarks do not pretend to exhaust this subject, but may be found helpful.

Wells.

28. Wells have this advantage that they are not absolutely dependent upon the rainfall, which is so precarious in Rajputana. Where good pucca wells can be made near tanks it is always good policy to make them, as they can generally be depended upon when the tanks are empty.

In dry seasons the opportunity should be taken to deepen any wells in which the supply of water is not sufficient. Money cannot be spent in a better way.

Sometimes kutchra wells are sufficient for temporary needs, and they can often be made at a small outlay and yield a good return. For example, Mr. Manners Smith in his Report on Jhalawar remarks of one place near

Dudalai : " Kutchha wells can be made, it is said, for Rs. 25 each ; each well can irrigate 3 bighas and yield a revenue of Rs. 9. In these wells the water appeared to be about 30 feet below the surface and about 10 feet deep."

In the sandy soil of Rajputana great difficulty is often found in keeping wells free from silting up.

The reason is, that generally the only inlet being from below (as the water is drawn from the well, and the level of the water inside falls), the pressure of the head of water outside forces sand with it from below.

The best way to prevent this is to sink the well in the first instance on to a permanent stratum of hard soil. If this is not possible then to plug up the bottom of the well with a good thick layer of fine gravel, and above this broken stone, which, while allowing water to filtrate upwards, will have weight sufficient to keep down the sand. Wells in such soil should be as large as possible, even long shallow trenches will sometimes answer ; if the surrounding subsoil water can enter gradually and at the same ratio as the quantity withdrawn, there will be equilibrium, no pressure upwards by the outside water, and no silting up.

In some wells courses of dry stone or brick or weep holes are left below the water surface, so that when the well is being used, and the water surface inside is lowered, water from the water-bearing strata outside is admitted gradually, and is not forced to enter from below.

In some cases in Europe after the well has been sunk to a certain depth the bottom is plugged with concrete (to prevent it sinking lower) around an iron cylinder of less diameter, say 3 or 4 feet, which is inserted, and is forced down by hydraulic jacks to any required depth, fresh lengths of cylinder being added as necessary.

The lower four or five cylinders are provided with small circular holes covered over with sheets of copper gauze. The bottom of the cylinder is filled with gravel or broken stone, and the top is domed over and provided with a plug. When it is necessary to clear the iron cylinder the plug is removed, and air pumped down with such force as to drive out all the silt inside through the small gauze wire openings and cause cavities to form outside them, into which the coarser particles of sand and gravel outside accumulate and help to filter the water and keep back the fine sand.

Where funds are available it might be worth while to try something of this sort. But as a rule in Rajputana we have to depend upon primitive measures.

Well water is generally preferred to canal or tank water, and greater care and economy is exercised in using the water.

The expenditure on wells can be carried out gradually, and does not commit a State to any large outlay in one place, the returns from which might not be realised for some time. The expenditure on such works is all in the State, is distributed over a large area, and yields an immediate return on the outlay.

The best sites for wells are in the margin of tanks or below them.

Deep Wells.
Jetting
Process of
Boring.

29. A new process has lately been adopted for the sinking of wells in America and Europe, known as the "Jetting Process." The principle consists in the forcing of water through a hose and swivel down the drill rods, and out of the holes in the drill. The swivel admits of the drill rod being turned; each time the drill falls the blades open and pry the earth loose, and then the stream of water carries the loose drillings up and over the top at the surface. Not only is the drilled material got out easily, but there is no danger of quicksands getting into the drill or jamming the rods.

Wells have been bored in England and in America successfully—

For Messrs. Ilford, Essex, 8" diam. 1,003' deep.

„ Fernie, at Fife Laundry, 6" bore to a depth of 365' in 16 days.

„ Barry, Kirkaldy, 8" bore 382' all rock in 21 days.

And in many other places.

How far such a system is applicable to Rajputana it is difficult to say, but is worth a trial, as many wells are abandoned or fail when most wanted, because there is not the means at hands to go deeper.

If the Government had some apparatus which could be borrowed or lent for the purpose it would be a boon to the country. It is hardly to be expected that any individual State can purchase special plant for isolated cases. Why should there not be one at least kept for the whole of Rajputana?

Irrigation
by
Electric
Power.

30. There are some who assert that it would be quite possible to irrigate by electricity in India, and who point to dams across rivers and long canals as perhaps necessary, but as old-fashioned and expensive. In an article, noted at foot of page 16, the writer suggests, "If properly irrigated an acre or two of land will easily maintain a native family," and he thinks "it would be well worth while for the Government or one of the native Princes to consider this question of systematic Irrigation by means of numerous small wells, each filled with a centrifugal pump and three-phase motor.

"In California the power for these motors is obtained from high head water power in the mountains, the electricity in some cases being transmitted 90 miles." The writer goes on to say: "In India it is probable that very little power could be developed in the mountains for Irrigation purposes, as they are too far away from the drought districts, but there is no reason whatever why large steam or gas-driven power stations should

not be installed in central positions. The deposits of coal in India are more widespread than is generally supposed. The coal may be of poor quality; but it is as good as the coal used in many Continental Stations."

Regarding the question of cost he says, "An Electrical Irrigation Scheme could be carried out piecemeal and tried at various centres on a comparatively small scale, as compared with the Engineering works now in hand or projected. Large central stations can now be built and operated very cheaply, and as for the high tension transmission lines, they simply consist of 3 copper wires each 0.324 in. diameter carried on wooden poles in iron sockets, concreted inside to protect against white ants, and spaced 40 to the mile. When working at high tension, say 20,000 or even 40,000 volts distance becomes of little moment, and the efficiency is easily kept over 90 per cent.

"The pumping plant is simplicity itself, consisting merely of a centrifugal pump attached at the bottom end of a vertical shaft. The top end projects above ground and carries a vertical three-phase motor with short-circuited rotor, the simplest piece of mechanism in the world. A starting switch combined with a float arrangement will enable the motor and pump to start and stop automatically if desired, so that they need only be examined once a week; it is probable, however, that the agriculturist will switch on the pumps as he requires them; as each motor is fitted with a sealed meter the amount of current is charged for strictly in accordance with the water pumped.

"For ordinary depth of 20 ft. or so a single centrifugal pump will do, but where the depths are greater two or even three pumps in tandem will meet any case likely to arise. The remarkable simplicity of a combined centrifugal pump and one three-phase electric motor does not appear to be recognised as widely as it should.

"Regarding the number of such pumping sets for any given area, this will depend on the situation and on the crops to be raised. In California they are spaced about $\frac{1}{4}$ -mile apart, and one farmer may have 10 or 20 on his property. In India it is a matter which experience would decide; there would be no liability to overdo the matter or waste public money, for if more wells are required in any given district it is easy to sink more and connect them up to the transmission line."

The writer goes on to say, "I am convinced in my own mind that the thing can be done and made both a technical and financial success..... Of course there are limitations to Electrical Irrigation, and I do not suggest that it can supplant altogether dams and canals, but it can be made a most useful helpmate to work already carried out and to some now projected.

"It is clear that the Indian Government cannot go digging canals and making dams for ever, and in any case large tracts of country could never

be reached by such means. Surely in such places Electric Irrigation is the thing."*

Rajputana is one of these large tracts to which the writer alludes, though the water is at a much greater average depth than he supposes, and the conditions are apparently very different from California; nor, considering the scarcity of fuel, the cheapness of labour, the want of capital and the sparse population, is it clear how Electric Irrigation at present can be carried out successfully in Rajputana. If we could only utilise the sun's heat what might not be possible in this country? At the same time it seems that the question is well worth consideration, because with the little information we have, it is impossible to say what can not be done.

If the question could be referred by the Government of India to a body of experts to report upon, not as regards Rajputana only, but as regards India generally, it would be the first step, for at present we know so very little of what is under our feet, or of the powers which are around us. Any increase to this knowledge may open vistas of which the present generation has no conception.

Raising
Water by
Compressed
Air.

31. Then there is the process of raising water from wells, rivers or tanks by means of compressed air, which may be applicable in some places where fuel is cheap. The process seems to have many advantages; whether it can be successfully introduced in Rajputana, where labour is cheap and fuel scarce, is doubtful. The apparatus is similar in operation to the steam Pulsometer, using air instead of steam.

The advantages are: no condensation occurs as with steam. In open wells fitted with steam or rod pumps, platforms and ladders have to be fitted to enable the men to go down for the purpose of oiling and packing rods and glands, but with this process the work is automatic, and no attention is required.

When working, a continuous stream of water is discharged to heights up to 300 feet. It is stated existing wells can at once be adapted for pumping by simply lowering the intake and pipes into the water, and so long as the air is supplied water rises.

The advantages claimed for this process are:—

- (1) The increased supply making one well yield as much as several wells not air-pumped.
- (2) The ease of raising; an air pipe is lowered down a well, air turned on, and water rises.

* From an article on "Irrigation by Electric Power in India." By E.K. Scott, A.M.I.C.E., M.I.E.E., in *Indian and Eastern Engineer* for January 1905, page 25.

Some useful notes on this subject will also be found in Technical Paper No. 157, by Mr. R. G. Kennedy, page 15.

- (3) The purification of the water. Water is sometimes unsuited for drinking purposes owing to gases and other causes, but the air when ærating the water purifies it.
- (4) The economy of transmission. One plant can supply power to work 1,000 wells if necessary over a great area; the entire water-raising requiring only the expense of labour and upkeep at one place, not at 1,000 places. In usual well-pumping, each well requires machinery and skilled labour, making Irrigation from any depth impracticable, but with the air process only one plant is required, and the labour and depreciation is reduced to a minimum.
- (5) Extremely low first-cost for deep-well work. It is said to cost only a fraction of other methods, such as Electrical transmission and power or steam, and enables any unskilled labour to obtain a water-supply from uncontaminated sources by simply turning on the compressed air.

In Rajputana, where fuel is scarce and labour cheap and other conditions are not altogether favourable, it is doubtful if this process can be successfully introduced for Irrigation, though it might for other purposes. It would be interesting at all events to see it tried.

This subject was brought to the notice of the Consulting Engineer by the Political Agent at Tonk (Major Pritchard), who forwarded a letter from Messrs. Enever Brothers of Lucknow, dated 31st October 1904, in which they say: "We could promise as a trial to have 10,000 acres of land irrigated within 12 or 15 months and paying a net profit of 20 per cent per annum."

In reply to a letter from the Consulting Engineer asking for information on several points they state: "Our Engineers have a very fair knowledge of parts of Rajputana.

"Tonk possesses, with parts of Kotah, several favourable conditions, such as ample water supply in rivers and wells, large and cheap supplies of wood fuel and very fertile soil. With a large and valuable collection of data (brought over from our American people who have made a speciality of this work), we worked out the cost for various prices of fuel and depths of water and wrote to Tonk accordingly."

Then they explain the terms on which they work, *viz.*,—

"An agreement with the State for us to carry out a work, giving results at a rate guaranteed by us and allowing of a very fair return to them—the State to take over after a certain period, if our guaranteed rates were realised.

"In all the work we guarantee a certain water supply at a certain cost, thus enabling the farmer to calculate cost of Irrigation. The number of wells sunk by us up to date is 500,000, including oil wells and prospecting bores.

"We generally guarantee a water-supply double the normal, i.e., double that which can be obtained by ordinary pumping, but by deepening our bores we often obtain ten times the normal. Thus one well can supply as much as ten wells worked by usual methods."

In reply to my enquiry if the firm would undertake any experiments in the northern parts of Rajputana, say in the Jaisalmer State, where there is such a want of water, if so, on what terms or conditions, they say,—

"We would point out that tube wells can be sunk much more cheaply than ordinary open wells could be constructed. A 300-ft. well in Jaisalmer would cost quite Rs. 7,000, while our price for a well yielding at least double would be about Rs. 3,000, or much less on a large order. In a country like Jaisalmer and for a large order we could probably guarantee one well a week, using one machine, and if urgent five wells a week, using five machines.

"The tube well air-lifting process should be very applicable in Jaisalmer, where most of the wells contain brackish water. It is extremely probable that fresh water exists below, and so the tube well could be sunk till this was reached and rose up into the tube.

"Before quoting terms for work in Jaisalmer, we should have to send an Engineer up to note local conditions. We would do this if you agree to pay his expenses there and back and a fee of Rs. 35 per day to cover his salary. This money paid could be deducted if future work was given there.

"Approximate estimates are attached.

"We may remark that the Irrigation water-supply carried out by us near Colorado was under even worse conditions than Jaisalmer. We were, however, fortunate to meet with some Artesian flows which gave us a good start, and water power existing 100 miles off was electrically sent for supplying power for water-raising.

"We sincerely trust you will earnestly consider the question of mechanically raising water for Irrigation, in districts where canals can never be constructed, and where we feel sure a sympathetic attitude would result in a great and surprising success."

The approximate cost was stated as follows:—

**"APPROXIMATE COSTS FOR WELL-SINKING AND WATER-RAISING IN THE
JAISALMER STATE.**

Tube Wells 4" Diameter.

Depth of wells	...	...	...	200 feet to water level.
Depth tube wells are sunk,	...	...	...	500 feet.
Estimated supply of each well	...	...	...	40,000 gallons per hour

“Cost of sinking and lining with galvanised wrought-iron piping Rs. 10 per foot, for fair contract say for 5,000 feet. :

“Two plants erected together each working five wells, situated within two miles of machines, delivered and erected within 100 miles of rail head, sufficient for raising 400,000 gallons per hour from above wells, Rs. 75,000.

“Approximate cost of raising would be 4·2 pies per 1,000 gallons, inclusive of fuel and labour, but not interest on Capital or depreciation.

“Fuel would be Bikaner coal gasified, obtained from Chameri, near Jaisalmer border.”

The Consulting Engineer for Irrigation then wrote to them, dated 13th February 1905, as follows :—

“You may be sure of a sympathetic attitude on my part and on the part of the authorities in Rajputana in such an important work as Irrigation. The difficulties are that it is impossible to recommend new schemes of this sort, unless we are perfectly satisfied of their proving a success.

“There have been cases in my knowledge where the very interest we sought to advance has been delayed for years and confidence altogether shaken because persons have been more considerate of their own advantage than of the interests of the Native State, or have been too sanguine (shall we call it?) and have bought their experience without any compunction at the expense of a Native State.

“I am taking it for granted that you are as anxious as I am that there shall be nothing of this sort. It is for you to guarantee this to the satisfaction of the authorities.

“The very favourable returns you anticipate make me think you are inclined to be too sanguine, for there are only too many who would be glad to invest money on such terms; in fact it would certainly be worth while for you to borrow money yourselves and carry out your schemes on almost any conditions, anywhere in British India. You may be sure one success of this sort would ensure you clients everywhere.

“If you can refer me to any place in India where you have been able to carry out any Irrigation successfully, I shall be glad to know all about it, and it will strengthen my hands.

“As regards your proposal to sink and line with galvanised wrought-iron piping, I should be afraid that in time the pipe would wear out and give trouble. Would it not?

“In the meantime I am communicating with the Political authorities concerned, as whatever action is proposed can only be with their approval.”

In reply to this they state as follows, in a letter dated 18th February 1905 :—

“In the case of a State taking up mechanical water-raising for Irrigation we would guarantee a certain return at a certain cost.

“If a suitable district for Irrigation is decided on, we would send an Engineer to investigate and produce plans and papers guaranteeing a certain amount of water at a certain cost, and we should not expect to receive payment for our machines or labour ; unless that result was good enough it would naturally not be taken up.

“There would be no risk to the State whatever. For our part we would require the experiment to be carried out over a fairly large area, and in case of success to be guaranteed the entire mechanical Irrigation work of that State or District, for we are a business firm and cannot afford to experiment for other people's gain.

“Should it be desired that a certain acreage be guaranteed, we would first have to mutually agree as to the quantity of water required per acre or unit, this amount varying according to climate and geological conditions, also according to the kind of produce raised.

“We can give thousands of references from England and America, but none for work actually yet carried out in India, having only just started a business for this purpose.

“The system as explained enables anyone to see its applicability for Indian conditions—the cheap and quick sinking of wells, and the increased supply of water from wells, by which one well sunk in our way yields the supply of several ordinary wells, etc.

“Regarding the lining of tube wells with wrought-iron galvanised piping, these if thickly galvanised are practically everlasting, but we also stock brass and copper perforated screens for use below water level.

One of the firm (Mr. Alexander Enever) was at Jaipur recently. Unfortunately the Consulting Engineer was away, so did not see him. He wrote afterwards (dated 6th March 1905) stating he had called while here on the Chief Member of Council, who, after seeing Mr. Enever, suggested (he says) “the putting down of a trial plant, and the idea being favourably received, we thought it well to write and see if you would order this to be done.

“We trust this will be favourably considered, and that we may be allowed to show what can be done in dry countries as protection against drought.”

In reply the Consulting Engineer wrote to them, dated 9th March 1905, suggesting they should submit a letter to the Durbar or to the

Superintending Engineer of the State (Mr. C. E. Stotherd), stating their readiness to put down a trial plant if desired, and the terms on which they would do so.

In the meantime I had sent the correspondence to the Resident, Western States, Rajputana, for his information, and asked if he wished any action taken as regards Jaisalmer, and received the following reply, which has been sent to Messrs. Enever :—

“We cannot enter on any scheme that is of a speculative or in the slightest degree of an experimental nature for Jaisalmer.

“Money can only be obtained from Government for the State, and it is doubtful whether Government would be inclined to sink any more money in the State, even if there was no doubt about the results of the scheme.

“Two factors are *prima facie* against Messrs. Enever Bros.’ proposals:

“(1) The difficulty of transport and the distance from a Railway.

“(2) The absence of fuel. The supply of wood fuel is of the most meagre description, and for the most part the State is destitute of wood. Camel dung and thorn bushes are the only things available.

“It strikes me that the cost of raising the water is understated by Enever Bros., if Jaisalmer conditions are considered. It is no good having even an abundant supply of water if it is costly, as it cannot pay to cultivate in Jaisalmer, when any extent of similar or better land is available elsewhere, and where cultivation by the same methods would be cheaper.

“Lastly, there is no guarantee that the deep water supply is unlimited. I have seen Tonk and I have seen Jaisalmer, and there is no comparison between the two places, and data taken from Tonk would not be applicable to Jaisalmer.

“I am told that a scheme like the one proposed was tried in Bikaner, near the Palana mines, but was a failure.”

The subject is of such general interest that this correspondence has been quoted. At present it does not seem very hopeful, as far as Irrigation is concerned, while labour is so cheap and fuel so dear, and Capital to introduce anything of this sort is wanting.

At the same time it may be found useful, where water has to be supplied from wells or by pumps for the supply of a town, such as Bharatpur or Jodhpur or Kotah, or when the secret has been discovered of utilising the immense power of the sun’s heat to generate electricity or provide the means to work machinery ; or the power of water flowing from the Himalayas can be harnessed and be made to do so.

There is a want of information about the formation of the earth's crust in Rajputana, or to what extent substratum water exists and can be depended upon. It would be worth while if this could be ascertained: it might lead to important results, as seen in the lignite coal measures at Palana, near Bikaner.

One State has already asked if this can be done, and for advice on the subject.

Raising
Water by
Wind
Power.

32. It seems strange that some use cannot be made of the power of the wind for raising water. In Canada it is largely used for domestic purposes and for cattle, but the discharge is small and discontinuous, and it is generally necessary to have a small iron tank to store the water raised when it is not actually required for use.

One drawback to windmills is, that so far all designs put the wheel out of action whenever the wind rises above a certain safe limit, thus losing all benefit from high gales.

Windmills have been tried in India for raising water, but it is believed hitherto they have not been successful. Considering the power of the wind—that it is found everywhere, that it is free to all, and that any use made of it would not lessen its value to others—it seems disappointing that it cannot be put to some good use. There is an open field here to anyone who can make the experiment.

In 1903 some experiments were carried out by the Royal Agricultural Society of England at Park Royal.

The windmill which won the prize is thus described: 16 ft. diam., 18 blades grouped in six sections, having an area of 131.32 sq. ft., with an available clearance area of 67.93 sq. ft. between blades and 30.88 square ft. at centre of wheel. Price complete, £70.

The pump is a double-acting syphon pump 4" diam. by 22" stroke; the working barrel is of gun-metal and valves of vulcanized India-rubber. The pump rod is of white maple 3" square, and is connected with the rack-casting by means of a 1 $\frac{3}{4}$ " wrought-iron pipe, guided through the tower head.

The tower consists of four angle-iron steel posts, with five intermediate angle-iron frames and diagonal tie-rods; at the bottom of each post are anchor plates, which are bolted to timbers let into the ground about 5 ft. deep. The general design and workmanship of this engine, in the opinion of the Committee, left little to be desired. It was supplied by Messrs. Goold, Shapley & Muir Co., Brantford, Ontario, Canada.*

The above particulars have been given here, as they may be helpful to anyone who cares to take up the subject. It is to be hoped that sooner or later some means may be found to make use of this great power in

* From a Report of the Judge, W. N. Shaw, Sc.D., F.R.S., with notes by the Society's Consulting Engineer, F.S. Courtney, M. Inst., C.E. Published by John Murray, Albemarle St., London, 1903.

India. At present it is entirely neglected. To the Government or to anyone who can solve the difficulty it would be worth a large fortune.

33. The procedure adopted in the Kishangarh State to promote well Irrigation is worthy of notice.

Procedure
in the
Kishangarh
State to
promote
Well
Irrigation.

There are two methods : (1) advances are given for making wells, and (2) concessions of revenue demand. For new wells $\frac{1}{10}$ th of the produce is taken during the first year, $\frac{1}{3}$ th in the second, and so on until it comes to $\frac{1}{3}$ rd, which is the usual amount.

On advances 6 per cent. interest is charged to cover failures which often occur in the trap. If the water is hard or useless for Irrigation, nothing is charged, and the loss is recovered from the interest derived from other wells. This is found to be a great encouragement.

Boring tools are lent by the Durbar, when a well has been sunk, to tap the spring, and in case of failure the cost of the experiment is refunded.

If a test-boring could be made beforehand it would lessen the chance of failure.

Money is advanced for agricultural purposes through village *panch-ayets*, and one-half or one third of the revenue is taken in lieu of interest. This amounts to more than 6 per cent. This system is chiefly adopted in Jagir villages, the State guaranteeing the payment of a moiety of the revenue. Subsidies are granted by the Kishangarh State to Jagirs at 6 per cent. interest.

Where there is a real interest in the welfare of the State the administration will find out and arrange for such measures as will best suit local conditions.

34. Most people think that the more sand hills the less a tract is fitted for Irrigation. In a small way Irrigation among sand hills has been developed, but it needs plenty of water. In one case (the tail of the Jakhri, Mozuffargarh) the whole surface seemed covered with sand hills, like Atlantic rollers in a great storm. Our means were slender, so we had to be content with driving through them tiny cuts, mere watercourses. Cutting down to bed level was only started when water was ponded in the upstream hollow, between the two ridges. The first rush would cause slips, but the water, aided by a certain amount of clearance, scoured a channel for itself. Some ridges gave a lot of trouble, some very little ; but once the passage of a fairly good stream was secured all trouble ceased. Probably the channels will never require another clearance. With large sections of channel the initial trouble would be far less. Greater head and volume of water would also greatly facilitate matters. As far as the space abstracted from the culturable area, it practically amounts to a very insignificant fraction of the total.* It was proposed to try this system with inundations from the Kantli River in Shekhawati some years ago, but owing to political and other difficulties it was not attempted.

Irrigation
even
among
Sand Hills.

*From an article, "The Irrigation of Khotan," in *Indian Engineering*, 11th February 1905.

Jhils

35. Jhils or hollow depressions can sometimes be drained, and if partitioned by small embankments, each part can be flooded separately or water can be stored to any desired depth, as exemplified in the Kaladeo Jhil in the Bharatpur State, and proposed at the Talwara and Surawala Swamp in the Bikaner State.

The Spill
from
Rivers.

36. *Road Embankments* may sometimes be utilised to divert or retain the overflow of rivers or surface drainage, as exemplified along the Byana-Oochain Road in the Bharatpur State. The road is carried on a raised embankment from Nekpur to Sewar, with flood regulators and sluices at intervals; and at Oochain a canal 50 feet wide has been cut parallel to the road, which leads a portion of the floods northward to Sewar and the vicinity of the Bharatpur city. The larger portion of the floods are, however, released at various points along the Byana-Oochain Road through regulators discharging in an easterly direction.

The flood water so discharged is impounded and distributed by other works, the largest of which is the Ajan Bund, an earthen bank extending for 12 miles across the direction of the flow, with a contour area of 14 sq. miles when full.

The Ajan Bund has a number of sluices and weirs through which the flood water can be led out to irrigate, and the basin can be emptied afterwards.

Formerly the inundations from the Bangunga did so much damage that they formed the subject of repeated complaint. Now, owing to the judicious way they have been controlled, stored and distributed by Mr. Devenish, State Engineer, the damage has been prevented, and profit is derived from what originally was a source of loss. This is a good object lesson of how a river of this sort may be successfully dealt with.

Submerged
Weirs.

37. *Submerged Weirs*, built across nullahs to hold up a few feet of water.—In the rains the floods pass over, and afterwards the water which is stored is raised by hand or bullock power to irrigate the fields on both banks; the percolation benefits the wells and springs below.

This is a feature in the Bundi State, where some 22 examples exist, and the rocky nature of the nullahs afford good sites.

There are said to be many suitable places in the Kotah State.

In some cases it may be advisable to leave openings, which can be used as scouring sluices and can be closed by planks in cut-stone groves.

Ravines—
Cause and
Effect.

38. One effect of not conserving water is that sometimes nullahs and watercourses from the hills descend with great force, cut the ground away, and extensive ravines and nullahs are formed.

The effect of lowering the nullah beds is to drain the country of water and to lower the level of the subsoil water to such an extent as sometimes to prevent cultivation.

Owing to the tendency which ravines thus formed have to increase, they yearly encroach on good culturable soil, and so year by year gradually reduce the area of good land.

These remarks are applicable to Karauli; and in the Kotah State are said to be causing a serious loss.

The damage occurs where surface water collects and in its onward course meets with a sudden drop; the earthen edge cannot resist the falling water and is gradually cut back.

One way to stop this is to divert the surface water elsewhere or over some place natural or artificial where it cannot cut back; or to store it somewhere, so that it shall be water at rest. Much depends on the cost of remedial measures, which may be prohibitive in some places. Ravines may sometime be bunded up with earth, so as to form large pools, the surplus water being diverted from one depression to another over the natural surface. The water so collected, as it soaked in, would benefit the wells near, the cutting back of the soil would be stopped to some extent, and the depressions would gradually fill up and form beds for *Talabi* cultivation.

The expense would be small, and if the experiment was tried in two or three places, in consultation with the Revenue officials, it would soon be seen if it was worth while to do more. It is a process which natives understand, and it would form a good sort of work for famine relief. The object is to retain the surface drainage where possible, instead of letting it run to waste and cut up the ground as it often does now.

39. In the Karauli State there is a system known as *pokhers* (i.e., fields in terraces formed by small bunds), in which rice is grown.

Fields in
Terraces.

It may be possible in some places to develop this system.

40. Poppy cultivation affords no protection against famine; it requires manure and watering every 8 or 10 days, and even in the Kotah State only forms 4 or 5 per cent. of the cultivated area of each village. It would not do to depend upon increased returns from opium cultivation in any Irrigation Project. Tank or Canal Irrigation must be based on other crops.

Poppy culti-
vation no
Protection.

41. Returns from Irrigation depend much on good supervision. The system adopted in the Jaipur State is a good example of how Irrigation works should be maintained.

Mainten-
ance and
Super-
vision.

There is an Abpaishi Code or set of rules printed in English and the Vernacular for the guidance of all concerned, with blank pages interleaved; a special establishment of Mahafizan, or watchmen who have to furnish security and must be natives of the State, to supervise and record the irrigated areas approximately daily at each place; Mohurrirs, or Munshis, to look after the Mahafizan; Girdawars to go round inspecting circles, and Naib Zillahdars and Zillahdars to go on tours of inspection. These latter are held responsible for all under them, and for the final measurements and returns.

Printed slips, at the close of the Irrigation season, are given to each cultivator and to the Tehsil, showing the amounts to be recovered, which are realised by the Revenue officials in the usual way.

A return for the whole district is submitted to the Durbar and a copy to the Engineer Office.

A statement is prepared by the Engineer annually showing the expenditure on Irrigation, the rainfall, the areas irrigated, and the revenue from each work, the percentage realised on each for the past year, and the total up to date.

The capacity of every tank is calculated for every foot in depth, and recorded in a register, so that before the Irrigation begins (allowing 40,000 c.ft. as a fair allowance for every bigah, including waste and absorption) it can be seen at a glance what area ought to be irrigated if the water is made proper use of. This is a good check upon all concerned.

The last annual printed Report of the P. W. D. in the Jaipur State shows interesting facts regarding Irrigation. These are briefly stated in the Appendix and need not be repeated here, but are worthy of notice and are encouraging.

Canals, Loss
and Duty
of Water.

42. Experiments made on the Nira Canal, near Poona, show that the average loss in the canal from evaporation, absorption and percolation amounts to one cubic foot per second per mile; and on some of the Punjab canals a percentage of loss varying from 20 to 30 per cent. of the discharges at their head. This shows how any great length of channel must affect the duty of water for Irrigation, and should be remembered in estimating probable returns.

The duty a canal can do is the irrigation it can do within the first 30 days. it is of little use to offer water when it is too late to use it.

Canals as
Feeders as
well as for
Irrigation.

43. It may not be always possible to secure a good basin for a Storage Reservoir on a river, but it may be possible to find good sites for storage on the country commanded by the canal, one below the other, and if they did not fill by their own drainage area, to fill them by means of the canals. Water is sometimes allowed to flow to waste for many weeks in the rains, which, if stored, would be of great value when water is needed for irrigation. The Parbati Canal in Kotah is an instance.

Tanks at convenient places, each sufficient to meet the demands of a few villages, will enable water to be better distributed simultaneously than if all depended upon one canal. These tanks need not be made all at once, but as funds are available and experience proved their usefulness.

Supply cuts might also be made from the main canal to every village tank and ensure it being filled every year, whether for irrigation or not.

An ideal scheme would be to have a large Storage Reservoir on a river with a canal from it, and to have small tanks near each important circle of villages which could be fed by the canal, not only in the rains but as often as required.

The canal would then fulfil the double purpose of a feeder, as well as for irrigation.

44. Canals if passing on sloping ground may often be used to catch all the surface drainage from the higher ground, by bunding up the nullahs which cross it.

Canals on
Sloping
Ground.

In the rains the canals are not required for Irrigation, but can be used to convey surplus water to village tanks. It is sometimes better to do this than to make aqueducts, as costing less and preventing water from going to waste.

The water intercepted by blocking up cross-drainage helps to benefit wells near; the depressions on the upper side silt up in time and can often be cultivated. A successful instance of this can be seen in the Jaipur State, where the canal from the Kalegh Sagur on the River Bandi has been so treated near Asalpur; also near the Chandsen Hill, where the canal from the Bhairu Sagur crossed watercourses from the higher ground, and there was fear of the canal being silted up by the sand brought down in the rains. A series of small earthen bunds were made across each nullah to block them completely and to spread the water over the soil, to be absorbed and benefit wells adjacent, as well as to stop all silt reaching the canal.

45. It may not always be possible or it may be too expensive to take a canal off directly from a Reservoir, owing to broken ground or other difficulties. This need not prevent the work from being carried out, as it may be possible to let the water down the nullah bed until it reaches a convenient place to take it away, and there to make the head works and start the canal.

Site for
Head
Works of
Canal.

Instances of this occur in the Jaipur State at the Kalegh Sagur, where the water flows six miles down the natural bed of the River Bandi; and at Ramgarh, where it flows about $1\frac{1}{2}$ miles before it enters the canal. Head works are made at each place.

46. (1) Regarding aqueducts on canals, sometimes it costs less and is better to bund up the nullah crossing and divert the surplus water if possible.

Aqueducts.

Syphons.

- (2) Regarding syphons there is a danger of them being blocked by silt or brushwood. If possible it is better to bund out or divert the water, or take it on in the canal or across it, with a level crossing. The level of the canal bed cannot be altered, but the bed of the watercourse often can be.

Escapes.

- (3) Regarding escapes to canals these can often be economically made where the H. W. L. of the canal coincides with the natural ground surface. If there is no bank at these places the surplus water will pass off gradually over the natural ground.

Outlet
Sluices.

- (4) *Sluice outlets to tank.*—In some places sluices are not provided, the water being baled out to a higher level or drawn by bullocks. This certainly prevents wastage of water. The ordinary round well on the water side, with cut-stone holes closed by removable wooden stoppers and a masonry culvert through the bund, with a masonry core-wall all round it in one or two places, is the common and ordinary method of controlling the water. The vertical iron sluice valve with gun-metal faces and raising rod, worked by a pillar with screwed head on the top of the bund or outlet well, is considered the best arrangement. The core-wall of masonry is put round the culvert to prevent any creep of water along the culvert masonry.

These brief remarks do not pretend to deal fully with these subjects, and are only noted here because these points have been met with in some places, and the suggestions made may be helpful in future.

Disputes
about
Water
Rights.

47. Greater interest appears to exist now than it did, on the part of each State, as to the value of water, and anxiety that its rights to its full share shall not be infringed; for this reason it may be as well to state the principles which have been followed of late years in dealing with disputes between States in such cases. They are as follows :—

- (1) Where a well-established tank exists which is fed by defined feeder channels or nullahs, no new dam or other obstruction may be placed in such feeder channel which would in any way obstruct or diminish the existing free flow of water into the established tank below.
- (2) In the case of an established tank there may be other tanks or *nadis* on the feeder channels above, equally well established as the lower tank. None of these upper tanks or *nadis* may have their dams raised, so as to diminish the flow of water, which it is presumed passed over them, when the upper dams were first made. In the event, however, of the upper tanks silting up, their dams may be raised to the extent required to compensate for the loss of storage capacity due to such silting up.

- (3) All surface water not running in defined channels may be impounded by the occupiers of the ground on which side water runs off.

The above three principles have been followed in recent years, for instance,---

- (1) The obstruction and total diversion by the Kishangarh Durbar (1896-97) of the principal feeder of the Government Bhim Tank at Tihari, near Srinagar, in Ajmer; the obstruction was ordered to be totally removed by the A. G. G., under principle (1) cited above.
- (2) The construction by Government of a proposed tank at Bithur, near Nasirabad, an urgently-needed and useful famine relief work, has been definitely abandoned under principle (1) above, because it interfered with the main feeder channel of the Istimrar tank of Baneori.
- (3) Similarly the proposed construction of a Government tank at Harmara, in Ajmer, was dropped, as it interfered with an old-established tank in Kishangarh.
- (4) In Merwara the raising of the weirs of an existing Government tank at Ratanpura was reduced after building from 3 to 1 ft. above their original level, as it was found that the extra height impounded more water than the tank had lost by silting up in course of years, and thereby diminishing the original amount of flow into a tank of the Rao of Mahonda, *vide* principle (2) above.
- (5) In 1896-97 the Rao of Masuda was prohibited under principle (1) from obstructing an existing open feeder channel, leading into the Government tank of Nioraie, near Nasirabad.

These facts have been quoted here, as questions of this sort often arise, and it may be convenient to have the above information at hand.

48. The good influence which Political Officers who take an interest in Irrigation can exercise is shown by the fact that in Mewar (Udaipur) the Political Agent, Major Pinhey, C.I.E., has induced H. H. the Maharana to carry out the suggestions made, after an investigation of the possibilities of the Mewar State and recommended by the Consulting Engineer. In Jodhpur Lieut.-Col. Jennings, C.S.I., on hearing of the suggestion that the inundations from the River Luni might perhaps be made more use of, at once addressed the Council on the subject. In Bharatpur, owing to the interest taken by Col. Herbert, who was then Political Agent, all the notes made by Mr. Housden, as to the possibilities of Irrigation in the Karauli State, were rescued from oblivion, and thus enabled the Consulting Engineer to have them now printed and placed on record.

Influence
which can
be exerted.

Much may be done by personal enquiry and a few kind words on the occasion of a visit, showing interest in any proposals or work in progress. Such action is not lost on the native officials, who are very quick to notice what meets approval in high places. Engineer officers, too, appreciate encouragement of this sort.

Some of the
causes
which re-
tard Irriga-
tion.

49. The following appear to be some of the causes which retard Irrigation in Rajputana :—

- (1) The resources of most of the States are limited. Some are in such financial straits that it is hopeless to expect any improvement without some help.
- (2) Hitherto want of knowledge what to do. Happily this is being gradually remedied, and owing mainly to the recent investigations of which this Report is a brief summary.

In every Native State all the principal rivers have been investigated, and much information obtained and placed on record, showing where work can be taken up and what it will cost, so that no time need be lost or doubt exist what to do.

- (3) Ill-considered schemes have been attempted in some places which have not fulfilled expectations, and so raised doubts as to the advantages of Irrigation.
- (4) Scanty population retards Irrigation. It is hoped that in time this will gradually improve. To provide water and encourage settlers are the best ways to secure this result.
- (5) The physical difficulties which of course cannot be avoided, such as hilly ground, deep-set streams, the beds of some reservoirs not holding water, friable soil; the expense of making proper dams, insufficient waste weirs, which have caused many tanks to breach; as well as want of experience and need of professional help.
- (6) The large percentage charges for establishment made on all works on which the advice of the Executive Engineer is given, in the Ajmer Provincial Division for example :—

As the majority of the Istimrardars are poor and in debt, this prevents assistance being asked for, with the result, especially in famine time, when they are obliged to afford relief to their tenants, works have been sometimes opened without surveys, plans or estimates; and repairs are executed without system and professional supervision. In consequence, money which has perhaps been borrowed for the purpose is wasted, and repairs to tanks are deferred till a breach occurs. (Superintending Engineer's Report on Istimrardars' Estates in Ajmer. See Appendix.)

- (7) The fear of undue interference on the part of the British authorities, leading to permanent charges or control of the work. Anything which makes a Native State think that help thus given will be the thin end of the wedge for interference is looked upon with suspicion and aversion.
- (8) Even in those Native States which have an Engineer officer of their own, the relationship between the Engineer and the Revenue officials must be thoroughly friendly. Cordial co-operation is essential to secure successful work everywhere, especially in a Native State.
- (9) Where the Revenue officials are left to develop Irrigation from works made by the Engineer officer independently, and the responsibility of the Engineer ceases when the work is completed. No one has so great an interest in promoting and proving the success of his work as the Engineer officer, and the more confidence placed in him, as a rule, the greater interest he will take in his work.
- (10) The absence of proper supervision and control after a work has been completed—to remedy defects, to hear what the villagers need, and the want of efforts to meet their requests.
- (11) The want of interest in Irrigation on the part of the authorities. Natives are very quick to notice matters in which an interest is taken by their superiors, and if they see no advantage in exerting themselves to promote Irrigation, very few will take the trouble to do so.
- (12) The necessity that water shall regularly, fully and promptly meet all demands in time for the first watering. Where this is not secured the cultivators lose confidence.
- (13) Sometimes Irrigation works only provide water to land already irrigated from wells, or to land which does not always require water, or where there are not people ready to take it. In such cases the returns will be unsatisfactory, and, leading to disappointment, will naturally retard progress.
- (14) When land has been assessed on certain terms for each description of soil, and if water is supplied from any tanks or canal only the water rate is shown as profit due to the work, it does not fairly represent all the benefits derived by the State or cultivator; and the returns being shown so small is apt to discourage future Irrigation Projects.
- (15) Where there is a fear or suspicion in the minds of the people that if any water is taken, the land (if not already assessed as irrigated) will be charged as fully irrigated, irrespective of the quantity or certainty of a regular supply, the cultivators hesitate to take water.

- (16) The prejudice which sometimes exists against making use of water which has been already stored and not hitherto used for Irrigation.
- (17) Where tanks have been formed and assessment has been made on them, it prevents the construction of other tanks on tributaries of those streams, as such new tanks would reduce the water supply to the old tanks and might cause complications.
- (18) In some places Jagirdars possess a large share of the land, but have neither the means nor the wish to do anything themselves, nor are they ready to enter into any arrangement with others to carry out any joint Project.
- (19) Villagers naturally object to Irrigation channels being cut through their well land, to reach land lying waste for want of water beyond.

If this cannot be avoided in any way, it needs tact and consideration to overcome opposition, or success will be retarded.

- (20) The want of a bold and liberal policy, combined with a hearty and steadfast interest in everything connected with Irrigation on the part of all in authority.

Points deserving of attention.

50. In addition to what has been already noticed, the following are points which have attracted notice in these investigations. The subject covers so much ground that it is difficult to include everything :--

- (1) Where the rainfall is so variable and uncertain, as in parts of Rajputana, it is advisable to have large Storage Reservoirs (when they can be made at reasonable cost), so as to store the water in good years to help make up for the deficiency of bad years.
- (2) That the water which it is proposed to store, now goes annually to waste in a country where it is sadly needed, and all the money which it is proposed to lay out would be spent in the country and among the people.
- (3) With reference to tanks in lands belonging to Jagirdars, it should be explained to them that it is a duty they owe to the State, and that it is to their own interest to make these efficient; that the only object in view is to promote their own welfare, and every help should be given to them to carry out such work.

If they are sensible they will see this. Too often it is more from want of means that they fail to do anything. Every consideration should be paid to their rights. If this policy is carried out in this spirit and with tact it will probably be successful.

If any money has been advanced to them, as soon as it has all been refunded the tank should be made over to them absolutely, and no interference be allowed.

One good example of this sort will inspire more confidence all round than anything else.

- (4) From the interest which has been shown by the Government of India in the welfare of Rajputana, it is hoped that means will be found to afford financial help in some way, for without this there seems to be little hope at present of much being done anywhere.
- (5) It should be remembered that Irrigation works cannot be expected to return full profit until in full working order. It is important, therefore, when any work is sanctioned, to provide funds liberally, and to get the work finished as soon as possible, and so prevent the annual waste of water, upon the full and proper use of which the returns so much depend.
- (6) It is of no use to take up Irrigation in a half-hearted sort of way. A real personal interest must be shown in the subject by all in authority and all concerned ; a bold and liberal policy is needed.
- (7) A systematic policy should be adopted if it is desired to promote Irrigation :—
 - (a) Enquiry by the Administration into the present condition of all tanks and wells—what repairs are necessary ? what new works are desirable ?
 - (b) All these works to be numbered and entered on a Register, and taken in hand in order of their importance.
 - (c) A return to be kept up annually showing what progress has been made during the past year, either in repairs or construction of new works. Some official to be held responsible for this ; where honest efforts have been made this will be gladly done.
- (8) A fixed amount to be set apart annually for Irrigation :—
 - (a) For maintaining existing works and increasing their efficiency.
 - (b) For the preparation of new Projects.
 - (c) If funds admit, for carrying out new works.
- (9) The necessity of proper supervision when survey work is undertaken anywhere.

In one State it was reported : "The State obtained the services of an overseer from Government, but there appears to have been no controlling local authority, under whose guidance the survey was carried out, so the reports are not to be depended on, and a good deal of the work will have to be re-done."

- (10) It is advisable to take advantage of any existing work first, because often much earthwork and material are ready at hand.
- (11) Village tanks have been found more often breached from want of sufficient escapes and neglect of repairs than from other causes, showing need of inspection and attention.
- (12) Sufficient advantage has not been taken of nullahs passing near existing tanks, to make supply cuts from them, so as to ensure the tanks filling every year.
- (13) The capacity of many tanks may be increased by using movable planks or falling shutters, on the crest of existing weirs. Plans of these are in the office of the Superintending Engineer.
- (14) Water supplied to good land gives a better return than if supplied to inferior soil.
- (15) The advisability of a proper understanding with the villagers concerned before money is spent. A share of responsibility should be placed on them, through their own Revenue officials, and some guarantee be taken to prove that they really desire the work.
- (16) When Projects are not properly prepared beforehand it often leads to wasteful expenditure afterwards.
- (17) The advisability of marking out Projects on the ground where possible beforehand, and putting permanent benchmarks while the surveys are fresh. The need to have these inspected and kept up, so as to avoid trouble and expense hereafter, which otherwise is sure to occur.
- (18) The advantages of having the contents of every tank recorded, for every foot in depth, so as to be able to keep a good check upon the use made of the water stored every year. About 40,000 c.ft. is generally ample per bigah, and includes evaporation, percolation and absorption.
- (19) The advantages of having proper supervision for maintenance ; for ascertaining the requirements of the cultivators ; seeing that water is properly supplied, properly used, and fairly charged for.

- (20) The advisability of getting the opinion of the local Revenue officials, and also of hearing all that the villagers have to say on every Project before it is taken up and also afterwards, to secure successful results.
- (21) There is such a thing as zeal without discretion. To repair some broken tanks may not be worth the outlay. For example, the Tejalao Tank, near Ganor in Banswara. If water was stored here, it was stated that the crops which are cultivated in the bed and nourished by the tank above would suffer.
- (22) Native States cannot afford to entertain large establishments. Capital charges should always be kept down as low as is compatible with efficiency.
- (23) Encouragement should be given to as large an extent as the State can afford, under proper conditions, to cultivators to make and improve wells, and to keep their tanks and Irrigation ducts in repair themselves. If these are State works, the State of course should do so.
- (24) Wells have this advantage that they are not absolutely dependent on rainfall, but are fed from natural springs. The best place for them is near village tanks. The money spent on them is spread over a large area, is all spent in the State, and is of permanent benefit, and very often the work can be done by the villagers themselves. Where the water is more than 75 ft. deep, well irrigation as a rule is not remunerative.
- (25) The advantages which follow when officials and those entrusted with the construction and maintenance of Irrigation work of any kind work harmoniously together. Those who cannot do so should be provided for elsewhere.
- (26) The advantage of having a diagram showing on one page the year, the rainfall, the area irrigated by flow or lift, the revenue realised, the amount expended for the past year and the totals up to date. It affords useful information at a glance.

This diagram is in use in Jaipur, and a copy of the form can be had from the Superintending Engineer if desired.

51. Before closing this brief summary I should like to record our appreciation of the way in which the Durbar of every State we have visited has received us, and helped us in our investigations, from the Maharajas, Political Officers and officials downwards. Every State seems to have recognised that the only object of the Government was to try and help them; the courtesy shown has been in keeping with the character of the Rajputs, and has helped to make the work a real pleasure.

Testimony
to the Dur-
bars and
Political
Officers.

Testimony
to Mr.
Manners
Smith, Sup-
erinten-
ding
Engineer,
and all
under him.

52. Personally, I should like to say how much I have appreciated the way in which Mr. Manners Smith, Superintending Engineer, has worked with me throughout these investigations.

The keen interest he has taken in the subject, and the energy and devotion to duty he has shown throughout have contributed largely to the results. We have received cordial assistance everywhere from the authorities, both European and Native. I attribute this greatly to the tact shown by Mr. Manners Smith in his intercourse with everyone.

The amount of work which has been carried out in so many different States under his supervision, the Surveys made, the Projects prepared and placed on record, reflect credit on his supervision and on all under him. Not only has all this been done without friction or complaint anywhere, but in the words of the A. G. G. for Rajputana we have, it is hoped, "succeeded in disarming opposition and even apprehension, and have interested each Durbar in turn in the operations."

If the suggestions which have been made are approved, and can be acted up to in a bold and liberal way, by the co-operation and goodwill of the Chiefs, there is good ground for hoping that great benefits will in time be realised.

S. S. JACOB, Col.,

Consulting Engineer for Irrigation in Rajputana.

Jaipur, 15th April 1905.

APPENDICES.

APPENDIX A.

No. 239.

FROM

W. B. GORDON, Esq.,

SUPERINTENDING ENGINEER, PUBLIC WORKS DEPARTMENT,

Secretary, Irrigation Commission.

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,

REVENUE AND AGRICULTURAL DEPARTMENT.

Dated 13th February 1902.

SIR,—

In my letter No. 135, dated 30th November 1901, I conveyed the recommendation of the Irrigation Commission that Mr. Manners Smith should be retained for a short time on special duty, in order to complete certain Projects for Irrigation in Rajputana. I am now to address you on the broader question of a general hydrographical reconnaissance of Rajputana as a whole. The Commission are very sensible that the question of the extension of Irrigation in India in any large and systematic manner cannot be treated piecemeal. But the nature of the problem in Rajputana is so simple and the first step towards its solution so obvious, while for reasons which will be presently indicated it is so exceedingly important that any action that is to be taken should be taken at once, that they feel no hesitation in making the present recommendation without waiting for the completion of their inquiries.

1. It is impossible to protect Rajputana completely against famine. No unfailing supply is available, such as the snow-fed rivers of Northern India afford, and all means of Irrigation, save the very largest or most favourably-situated works, fail almost completely under such conditions as have lately prevailed in that province.

2. On the other hand almost all do some good, even in years of severe drought; which all help, by increasing the resources of the people in ordinary years, to render them better able to support the stress of famine. The very impossibility of complete protection renders it all the more important to utilise to the utmost such means of protection as exist. At present a large body of water annually runs useless through this exceedingly insecure area, to the sea; and the problem to be attacked is, to reduce this waste to a minimum. Its utilisation must be effected by

means of dams and storage tanks, for in many parts of Rajputana wells are themselves very largely dependent upon percolation from each storage for their supply of water.

3. At present, however, we are ignorant of the exact capabilities of the country for the storage of surface water, or the manner in which they can best be made use of; and the first thing needed is to collect and record this information. A good deal has already been done during the past few years. Where the State employs a competent Engineer, useful Projects have been prepared, some of which have already been carried out, or are in progress. Where it does not, an Engineer lent and paid by the Supreme Government has been employed for some months past (Mr. Manners Smith) in a similar manner, and the Government of India have been asked to sanction his retention on the work till he has completed the schemes which he has in hand. All these Projects will be invaluable should famine recur, and they should in all cases be completed at once. They are the schemes which appeared, upon a cursory examination of the country, to be the most promising.

4. But the Commission are of opinion that much more than this is wanted if the maxim that it is wrong to allow a drop of water to run to waste in Rajputana is to be acted upon to the fullest possible extent. What has been done already has been done in a somewhat spasmodic manner, and often more or less hurriedly. What is now wanted is the systematic examination of Rajputana as a whole, based upon its physical features rather than upon its political divisions, to which latter, regard would be paid only so far as is necessary to secure the rights in water of the several States.

Each catchment should be taken up in turn and an Irrigation reconnaissance made of it from its head downwards. Such a reconnaissance would enable the Engineer to say where dams can best be placed or water stored, and the more detailed Surveys upon which Plans and Estimates would be based would follow in due course, though all of them need not necessarily be undertaken at once. It will be sufficient to keep always in readiness such detailed schemes as will afford an ample programme for relief should famine again occur.

Enormous sums of money have been wasted for want of a proper Survey and professional skill.

5. No such previous famine is on record as has recently affected Rajputana. The Chiefs have had a terrible lesson. While they have found themselves responsible for very large expenditure upon famine relief, the revenue from which alone it can be met has greatly fallen off, and the revenue-paying capacity of the State will in many cases take years to recover. At the present moment Chiefs and people alike are all most anxious to do anything that may be possible to protect themselves

against the recurrence of such a calamity. The Commission's visit and the preparation for it have drawn still further attention to the question of protection, and such a favourable opportunity for systematic and sustained action will perhaps never occur again. The Commission have little doubt that almost all the Chiefs will join in the scheme for a systematic Survey, and will either set their own Engineers to work or consent to Government setting theirs. Some few may stand out, perhaps, but not enough to impair the scheme materially. If, on the other hand, better years should supervene before action is taken, we shall have to wait for another famine before anything can be done.

6. The States are almost all just now in financial straits; and there is not much hope that many of them will be able to spare money immediately, even for promising Irrigation Projects. But the general Survey, and even the preparation of Plans and Estimates commits them to nothing. As their finances improve they will probably be glad to take up some of the most promising schemes as productive works. Some of them, it is understood, are even now ready to borrow for this purpose if the Government of India will lend the money, and I am strongly to recommend that all reasonable encouragement may be afforded in this direction. In any case, when the next famine comes, the existence of the Projects in question will ensure relief labour being employed to the best advantage. All that is possible will have been done to help the States, and they will know exactly what is feasible and advisable.

7. Where the State already entertains a competent Engineer he would conduct the Survey. In the other States (mostly small ones) the Government Engineer already employed in completing Projects should, the Commission think, be retained for the purpose.

But to secure success some supervising agency is required, otherwise the Engineers of different States may plan to utilise the same water. Moreover, some of the schemes, not many, but mostly large ones, will require the co-operation of several States. And, finally, some of the State Engineers will be glad of supervision and assistance. I am therefore to suggest the appointment of a "Consulting Engineer for Irrigation in Rajputana," and that the States should be asked to instruct their Engineers, who are mostly officers lent by the Supreme Government, to consult him. He would then practically direct the whole Survey.

I am to suggest that the pay of the Consulting Engineer and also of the Executive Engineer for the smaller States should be met from Imperial funds, and that efforts should be made to induce Col. Jacob of Jaipur to accept the former appointment. He is respected and trusted by the Chiefs throughout the Agency; his success in Jaipur is known to all; and he, if any man, can carry them with him in such a scheme.

8. The Commission have had evidence of several instances both in Rajputana and elsewhere of Surveys and Plans and Estimates being lost.

I am therefore to recommend that all Irrigation Surveys and Projects should be printed. The time, labour, and money wasted when one such set of papers is lost would pay for the printing of many sets. And in Rajputana this would be specially advisable, in order to save the schemes from the State pigeon holes.

I have the honour to be,

Sir,

Your most obedient servant,

W. B. GORDON,

Secretary, Irrigation Commission.

APPENDIX B.

RAJPUTANA ADMINISTRATION.

PUBLIC WORKS DEPARTMENT.

No. _____

Dated _____ 190 .

FROM

THE CONSULTING ENGINEER,

PROTECTIVE IRRIGATION WORKS, RAJPUTANA.

To

THE _____

SIR,—

With reference to the subject of Irrigation in Rajputana I have been asked to communicate with you as regards the..... State.

2. From the correspondence which has already taken place (noted in the margin), you will doubtless have noticed the interest which the Government of India take in the subject—

Letter No. 3255-I.A., dated 2nd August 1902, from the Government of India to the Hon. the A. G. G. in Rajputana.

- (a) The fact of the Irrigation Commission being appointed to collect all the information available.
- (b) The promptness with which the recommendations made by the Commission have been acted upon, to appoint special officers to supervise the investigations considered necessary.
- (c) The liberality with which the Government of India have acted, in undertaking to defray, in the first instance, the initial cost of the investigations.

All these facts show that the Government of India are determined to do all that can be done to help the Native States in Rajputana.

3. Colonel Sir Swinton Jacob, who has for many years been in Rajputana, and has taken an interest in the subject, has, at the request of the Government of India, consented to forego his intention to retire, and has accepted the post of Consulting Engineer for Irrigation, with the hope of being able to help in the great object which the Government of India have in view, *viz.*, the welfare of the States of Rajputana.

4. The Honorable the Agent Governor-General is assured that these disinterested efforts of the Government of India will be responded to in the same spirit by the Rulers of the Native States concerned.

5. There are three stages of operations--

- (1) The investigation of each catchment area, from its head downwards, to find out where dams can best be placed or water stored, and to ascertain all the possibilities in the way of Irrigation in each State. For this no detailed Surveys are necessary.
- (2) The inspection by the Consulting Engineer for Irrigation of all such proposals, to give assistance or advice where required.
- (3) The preparation of proper Plans and Estimates for a certain number of approved Projects in each State. (See letter No. 329, dated 13th February 1902, para. 4, from the Secretary of the Irrigation Commission to the Secretary to the Government of India, Revenue and Agriculture).

6. It is at present to the first stage only that it is desired to direct the particular attention of all concerned. This investigation should be started at once by the Local Engineer Officers, who should take up the subject in real earnest. They should themselves examine every catchment, or depute some intelligent subordinates to do so; and, without going to the trouble of making out elaborate Surveys or Estimates, they should be able to place sufficient data before the Consulting Engineer as will enable him to form an opinion and give advice on the proposal.

7. If the State Engineer is able, with the existing establishment, to arrange for making the investigation, he should do so at once. If he is unable to do so, he should state without delay what extra establishment is required, and whether the State is prepared to meet the cost of this extra establishment.

8. Irrigation has admittedly not been taken up in many States of Rajputana with the energy and spirit that its importance deserves. The Government of India, in the interests of the States of Rajputana, desire that not a drop of water which can be stored and made use of should be allowed to go to waste. It is only by the cordial co-operation of each Durbar and the Local Engineer or officials that anything can really be done to secure this great object.

9. May I ask you, therefore, to give the enclosed copies of this letter to the Durbar and to all concerned, with the hope that no time will be lost in making the required investigation, and informing the Consulting Engineer, so that he may go direct to the places marked and give any advice or assistance required. Time is short, the work is urgent, and should be done as soon as possible.

10. It should be clearly understood that no actual scheme will be commenced, or any expenditure upon it incurred, without the express concurrence of the Chief within the limits of whose State it is situated.

I have the honor to be,

Sir,

Your most obedient Servant,

APPENDIX C.

Copy of letter No. 4420 I. A. dated the 24th September 1903, from the Deputy Secretary to the Government of India in the Foreign Department to the Honorable Mr. A. H. T. Martindale, C. S. I., Agent to the Governor-General in Rajputana.

I am directed to refer to the letter from your Secretary in the Public Works Department, No. 3327 S., dated the 7th July 1903, which transmitted, with your remarks, a report by Colonel S. Jacob, K.C.I.E., on the scheme for a systematic examination of Irrigation Projects and facilities in Rajputana. It appears that the Maharana of Udaipur has practically signified his acquiescence in the scheme, and that it has been formally accepted by the other States and Chiefships in Rajputana. Considerable progress has already been made, and arrangements have been concerted for carrying out the necessary Surveys. These results are regarded with satisfaction by the Government of India.

2. The letter under reply furnishes estimates of the probable cost of the operations, with an indication of the manner in which it might be possible to make recoveries from the Durbars concerned. At the same time you strongly support Colonel Jacob's recommendation that the whole of the charges should be borne by Government, and that the States should at once be informed that no refund on account of these preliminary investigations will be required from them. In approaching this question the Government of India have borne in mind the cardinal principle that it is their first duty to safeguard the interests of the British Indian taxpayer. There can, however, be little doubt that, on the one hand, the examination of well-devised systems of irrigation in Rajputana will be of great practical benefit to British India, and that on the other hand, the successful completion of a comprehensive scheme is likely to be much hampered unless Government accept the charges for preliminary investigation. There are, moreover, great difficulties in the way of a fair apportionment of charges among the different States, and any attempt at such apportionment would probably give rise to misunderstanding. The advantages to be derived from the scheme may be thus defined :—

- (a) The result of successful irrigation is increased produce and an increased number of passengers from the irrigated native territory, to be carried over railways contributing to Imperial Revenues.
- (b) The result of increased produce is increased business in the ports and marts situated for the most part in territory under British rule.
- (c) Successful irrigation is the best preventive of famine (since railways are rather palliative than preventive), and experience has shown clearly that in a severe famine

season the efflux of an impoverished population from famine-stricken Native States becomes a direct pecuniary burden on the Imperial Government and a source of great administrative difficulty.

- (d) Famine in impecunious Native States (and there are many such in Rajputana) practically necessitates loans to such States from the Imperial exchequer, and however necessary the granting of such loans may be, it is worth a good deal to obviate or diminish the necessity.

These advantages would not perhaps in themselves be sufficient to justify the Government of India in throwing the cost of Surveys and Projects for works intended to benefit directly the Native States upon the British Indian tax-payer. The present Projects, however, are the direct outcome of the recent severe famines, and in these circumstances justification may be found for their being treated in a generous spirit by the Paramount Power.

3. The Government of India accordingly accept your recommendation, and you are authorised to inform all concerned that as a very special case it has been finally decided to relieve the States and Chiefships of all charges connected with these preliminary investigations.

[TRUE COPY.]

SUPERINTENDENT,
P. W. Secretariat, Rajputana and C. I.

APPENDIX C.

Copy of letter No. 3409 I. A. dated the 14th September 1904, from the Deputy Secretary to the Government of India in the Foreign Department to the Honorable Sir A. H. T. Martinale, K. C. S. I., Agent to the Governor-General in Rajputana.

I am directed to refer to the correspondence ending with the letter from the Government of India in the Foreign Department, No. 4420 I-A., dated the 24th September 1903, regarding the scheme for a systematic examination of Irrigation Projects and facilities in Rajputana.

2. The immediate object of the Survey, which has been instituted under Col. Jacob's supervision, was to take stock of local conditions, and ascertain which are the most promising schemes, primarily with a view to prevent money being wasted, as in the last famine, upon unsuitable or ill-considered works, and to ensure that what is spent on relief works in the next famine is spent to the best advantage. The reconnaissance work which has now been completed in several of the States in Rajputana is only preliminary, and until proper plans and estimates have been prepared, the schemes are not available for famine or any other purposes. It is therefore to be desired that plans and estimates should now be prepared, and when the financial condition of any State permits, encouragement may be given to carry out works which have been shown to be feasible, and to have a protective or even perhaps a productive value. At the same time it must be remembered that when the Irrigation Commission suggested this hydrographical survey of Rajputana, it was anticipated that one of the strongest objections which the Durbars might be expected to entertain to it, would arise from the fear that they would be pressed to spend money upon the works which are shown to be feasible, and care was taken to point out that this was not intended. Should, therefore, any of the Durbars be under the impression that it is intended to bring pressure to bear upon them in the matter, I am to suggest that an early opportunity should be taken to dissipate this suspicion. The Survey is not yet complete, and if one Durbar sees another pressed, as it believes, to spend money on these schemes against its will, opposition or obstruction may be aroused, which may do far more harm in the end than the mere postponement of the execution of a few protective works.

[TRUE COPY.]

SUPERINTENDENT,

P. W. Secretariat, Rajputana and C. I.

APPENDIX D.

Statement of work done in States which have Engineers of their own.

The following States which have Engineers of their own have been visited by the Consulting Engineer for Irrigation in Rajputana, and reports on each written by him:—

1. Jaipur.	5. Jodhpur.
2. Alwar.	6. Bikaner.
3. Bharatpur.	7. Kotah.
4. Dholpur.	8. Jhalawar.

The Government of India (letter No. 3836 I.-A., dated 17th October 1904, Foreign) wishes that Projects in the Jhalawar State should be surveyed and prepared under the direction of the Superintending Engineer, Protective Irrigation Works.

This State was therefore visited in February 1905 by him. The Projects as shown in Appendix E are being surveyed. Plans and Estimates for these will be submitted later.

APPENDIX E.

The investigation in each of the following ten States has been made by the Superintending Engineer, Protective Irrigation Works.

The Consulting Engineer has also made a tour of inspection in each (except Ajmer), to visit the Sites and Projects suggested.

A report on each State, with a Note by the Consulting Engineer, has been submitted, and the Projects approved by the Consulting Engineer have been surveyed and Plans and Estimates submitted or are in hand.

List of Irrigation Projects which have been prepared by Mr. Manners Smith, Superintending Engineer, for States which have no Engineers or Engineering Establishment.

Name of State and Projects.	Amount of Estimate.	REMARKS.
Mewar.	Rs.	
1. Banas Canal Project	40,71,646	Submitted.
2. Canal Project from Naogaon on the River Banas ... ..	...	Will be taken up as soon as possible.
3. Thala Storage Project on the Kothari River ... ..	...	Being surveyed.
4. Meja Storage Project on the Kothari River ... ..	...	Do.
Bundi State.		
1. Burda Project	2,09,046	Submitted.
2. Haripura Project... ..	1,77,310	"
3. Bundi-ki-Gotra, Pipalwasa	2,33,675	"
4. Pai Balapura	83,073	"
5. Neth	30,777	"
6. Dhaora Project	13,229	"
7. Khera ,,	21,971	"
8. Takro ,,	10,077	"
9. Mej River Project at Gudha	3,02,260	Submitted on 15th April 1905.
<i>This completes the work in the Bundi State.</i>		

Name of State and Projects.	Amount of Estimate.	REMARKS.
Sirohi State.		Rs.
1. Sukri River Project	1,16,290	Submitted.
2. Ora Project	1,16,299	"
3. Scori	42,577	"
4. Bhula, near Rohira	95,835	"
5. Completing Sirohi new Tank	21,848	"
6. Khemeri River Project... ..	1,74,341	In the Press.
7. Baldah Nullah Diversion Project	5,240	"
8. Kalandri ... ..	...	In hand.
9. Motagaon ... ..	...	"
10. Jhanapur Feeder ... ..	...	}
11. Mandwara ... ..	...
12. Kui ... ..	...
13. Girwar ... ..	...
Kishangarh.		
1. Dhanma Project	61,654	Submitted.
Tonk State.		
TONK PARGANNAH.		
1. Bagri ... ..	...	}
2. Haripura ... ..	...
3. Sandero ... ..	...
4. Miarampura ... ..	...
5. Dakia ... ..	...
6. Achnero... ..	...
ALIGARH PARGANNAH.		
1. Bamnia Project... ..	...	}
2. Oklano Project ... ..	...
3. Kherli ... ..	...
4. Bhagwanpura and Alipura ... ..	...
5. Mandawar ... ..	...
6. Kamaria ... ..	...
7. Raimanpura ... ..	...
8. Tekria ... ..	...

Name of State and Projects.	Amount of Estimate.	REMARKS.
Tonk State—Contd.	Rs.	
NIMBAHERA PARGANNAH.		
1. Kadmali River Project	Surveys completed. Project in hand. Projects suggested and Durbar asked if they wish them surveyed and worked out.
2. Sabauli . . . . .	...
3. Chota Kotri . . . . .	...
4. Kheri, near Sewaria . . . . .	...
5. Bangrera . . . . .	...
Jhalawar.		
PATAN TEHSIL.		
1. Shamia	
2. Ram Nawas Ghat . . . . .	...
3. Rewa River Project at Khod . . . . .	...
PANCHPAHAR TEHSIL.		
4. Gunjpura	Being surveyed.
5. Naka Sarna, near Guraria . . . . .	...
AWAR TEHSIL.		
6. Gunjwa . . . . .	...
7. Singhpura . . . . .	...
8. Khandar . . . . .	...
9. Rajpura . . . . .	...
10. Baria (two tanks) . . . . .	...
11. Benaiga (two tanks) . . . . .	...
DUG TEHSIL.		
12. Poula . . . . .	...
13. Manglia (two sites) . . . . .	...
14. Dug (one mile south of town) . . . . .	...
15. Partigarh . . . . .	...
16. Jamunia . . . . .	...
Dungarpur State.		
NEW PROJECTS.		
1. Thana	In hand.
2. Obri . . . . .	...

Name of State and Projects.	Amount of Estimate.	REMARKS.
Dungarpur State—Contd.		
RESTORING AND IMPROVING EXISTING DAMS.	Rs.	
1. Gengi Tank	} In hand.
2. Pagara	
3. Sulie	
4. Waei	
5. Kantri (two tanks)	
6. Pojpur Tank	
7. Pichlana	
Banswara.		
RESTORING AND IMPROVING EXISTING DAMS.		
1. Khorpi Tank, with feeder to Dadelao at Banswara	} Survey completed. Project in hand.
2. Feeder to Daila Tank at Banswara	
3. Bandanwara Tank, near Chinch	
4. Jethor, Nowa and Moria Tanks	
5. Sadarai Tank, at Khamera	
6. Jaila Tank at Dilwara	
7. Tank at Chota Padur	
8. Taije Lao and Kansla Tanks at Loaria...	...	
Partabgarh.		
1. Feeder to Gandhar Tank	} Do.
2. Bajrang Garh Tank Project	
3. Gadha-ghang Tank Project	
4. Weir between Chaniakheri and Sakria village	
5. Weir and improvement to Panmori Tank	
6. Pertabgarh City water supply. Proposed Tank by Maharawal's Bungalow	
Shahpura Chiefship.		
1. Arur Project on Mansi River	4,37,842	} Submitted.
2. Bhimpura	4,00,283	
3. Dikola	60,410	

Names of States and Projects.	Amount of Estimate.	REMARKS.
	Rs.	
Istimrari Estates.		
1. Khari River Project	1,70,763	} Submitted.
2. Feeder to Surajpura Tank, Bandanwara	9,598	
3. Feeder to and improving Naiki Tank, Junia	6,747	
4. Kalianipura Tank	14,021	
5. Koda Kalianipura Tank	8,371	
6. Restoring Ganesh Sagar, Sarwar ...	8,383	
7. Completing Pagaria Tank, Pisangan ...	5,879	
8. New Tank at Fatehpura	12,460	
9. Completing Gulab Sagar, Kharwa ...	8,106	
10. Completing Ranjit Sagar, Pranhera ...	14,027	
11. New Tank at Mangliawas	13,031	
12. Satana Tank at Satana	} Project surveyed. Plans and Estimates in hand.
13. Feeder to Bara, Dhomia, Dujota Tanks at Junia ... ..	...
14. Feeder to Khera Tank, Para ... ..	...
15. Nadi and Kalera Tanks, Sawar ...	...
16. Restoring Gopal Sagar, Sarana ...	...

APPENDIX F.

Statement of Expenditure incurred up to the 31st March 1905 in preparation of Reports and Irrigation Projects connected with Protective Irrigation Works, Raiputana.

Number.	NAME OF STATE.		Pay of Surveyors, Khallasces, etc.	Pay of Superintending Engineer and his office, etc.	Pay of Consulting Engineer and his office, etc.	Total.	REMARKS.
	STATES WITHOUT ENGINEERS.		Rs.	Rs.	Rs.	Rs.	
1	Mewar	...	15,886 A	21,790 A	9,099 B	46,775	A—This includes nearly the entire cost of surveys and preparation of Banas Canal Project.
2	Bundi	...	5,846	9,491	4,533	19,870	
3	Tonk	...	2,044	3,318	4,533	9,895	
4	Sirohi	...	3,018	4,899	4,533	12,450	B—This includes Consulting Engineer's pay during his reconnaissance of Banas and Kothari Rivers.
5	Kishangarh	...	842	1,368	4,533	6,743	
6	Shahpura	...	2,101	3,410	4,533	10,044	C—This includes Rs. 3,000 for cost of surveys in connection with Banas Canal Project in Istimraii Area.
7	Banswara	...	616	1,000	4,533	6,149	
8	Dungarpur	...	441	715	4,533	5,689	
9	Purtabgarh	...	402	653	4,533	5,588	D—This includes Rs. 1,000 for cost of surveys in connection with Banas Canal Project in Jaipur State.
10	Jhalawar	...	893	1,450	4,533	6,876	
11	Istimraii Estates	...	5,607	5,544 C	.....	11,151	
12	Karauli	...	.....	2,484	1,981	4,465	
	STATES WITH ENGINEERS.						
13	Jaipur	...	500 D	500 D	4,533	5,533	
14	Alwar	...	.....	.....	4,533	4,533	
15	Bharatpur	...	.....	.....	4,533	4,533	
16	Dholpur	...	.....	.....	4,533	4,533	
17	Jodhpur	...	.....	.....	4,533	4,533	
18	Bikaner	...	.....	.....	4,533	4,533	
19	Kotah	...	.....	.....	4,533	4,533	
	Total		38,196	56,622	83,608	1,78,426	

APPENDIX G.

APPENDIX G contains a brief summary of the principal points connected with Irrigation in each State. It does not enter into all the Engineering details or give all the information contained in the Notes which have been prepared on each Project. All will be found in the Reports which have been printed and submitted. This is merely a brief abstract from those Reports put together in one place for convenience of reference. Some of the suggestions made are applicable to every State.

ALWAR.

Alwar.—In the Alwar State about one-third of the area is hills. Where plains exist between the hills the ground is extremely friable, and the streams have deep-set and porous beds, and in such parts dams for storage on any large scale for Irrigation are useless, as the configuration of the ground is unfavourable to storage basins, and the land is so broken up that water could not be easily brought over it. There is cultivation in the wider ravines or nullah beds, which is irrigated by wells.

It may be feasible in some places, in the vicinity of Ghazi-ka-Thana for example, to bund up shallow ravines with earth so as to form large pools, the surplus water being diverted from one depression to another over the natural surface.

The water so collected, as it soaked in, would benefit wells near; the cutting back of the soil would to some extent be stopped, and the depressions would gradually fill up and form beds for *Talabi* cultivation. The expense would be small, and if the experiment was tried in two or three places, in consultation with the Revenue officials, it would soon be seen if it was worth while to do more. It is a process which natives understand, and it would form a good sort of work for famine relief. The object is to retain the surface drainage where possible, instead of letting it run to waste and cut up the ground, as it often does now.

On the eastern half of the State there is a considerable extent of plain. Here, however, Irrigation works are debarred, owing to water rights over the streams claimed by the neighbouring States.

On other parts of the plain where tanks can be made without question, most of the available sites have been utilised. When such tanks have been formed and assessment has been made on them, it virtually prevents the construction of other tanks on tributaries of the streams closed, as such new tanks would reduce the water supply into the old tanks and cause complications. A reference to pages 5 and 6 of the Report on Irrigation in the Alwar State will explain instances, and show the drawbacks of which Mr. Macdonald, the late State Engineer, complains.

Hardly a site, he states, remains where a tank can be made without either submerging well land or without well land lying between the dam and the ground which can be cultivated from the tank. Villagers naturally offer strong opposition to Irrigation channels being cut through their well land, even though land lying waste for want of water lies beyond it.

Out of the whole number of tanks (102) in the State only three can be said to hold water from one year to the next. On all other tanks it seems to be an established rule that the sluices should be opened at the beginning of the cold weather and the water be run off as fast as possible, so as to allow the tank bed to be cultivated.

"Villagers," Mr. Macdonald states, "clamour for old bunds to be repaired and new ones made, and when their wish is gratified will not, unless under great pressure, break up new ground, so long as they have wells to work. They trust to their wells for their means of livelihood and payment of their rent. It follows that many of the tanks are undeveloped and the good they do is mainly indirect."

It would be interesting to know what the villagers have to say in the matter. In any case it points to the advisability of a proper understanding with them before money is spent; a share of responsibility should be brought to bear upon them beforehand, through their own Revenue officials. It seems as if there is something wrong when "great pressure" has to be used to make anyone take water. Irrigation is not likely to be a success under such conditions.

The Report of the late State Engineer (Mr. Macdonald) shows the difficulties which had to be met.

Whether the relationship between the Engineering Department and the Revenue officials was as intimate as it ought to be, appears doubtful. Cordial co-operation is essential to successful work anywhere, especially in a Native State.

It is a question for the Durbar to consider whether it would not be advisable to throw more responsibility upon the Engineer as regards the distribution of water from Irrigation works which he has carried out; no one would have so great an interest in promoting and proving the success of his work as the Engineer Officer.

The present State Engineer, Captain Garrett, R.E., is an exceptionally able young officer and takes keen interest in his work, especially in Irrigation; and notwithstanding all the difficulties which have been alluded to, he is trying his best to do what is possible.

The Consulting Engineer for Irrigation visited Alwar on two occasions, in April 1903 and October 1903, and went with Captain Garrett to all the places on which opinion was desired, *viz.*, Birkiri Bund, Dherora Weir, Sirsa Devi Project, Ruparel Ghat and Laswari, Rampura Project, and the proposed water supply for the town of Alwar. He prepared a Note on each Project, which was printed with his "Report on Irrigation in the Alwar State." It is unnecessary to say more here.

The dispute with the Bharatpur State regarding the water of the Ruparel was one of the points referred to the Consulting Engineer for opinion. He went through all the correspondence from the year A.D. 1833, and submitted a Note on the subject. The whole of the correspondence, including Note by the Political Agents of Alwar and of Bharatpur, has been printed, and forms a volume of 118 pages, to which reference can be made by anyone who wishes to know the facts of the case. The conclusions he came to were: The agreement of 1837 regarding the division of the water between the two States is concise and has been admitted. That while Alwar has the right by this to use its allotted share of the

water at all seasons, it is not permitted to cause any obstruction to the free passage of the share allotted to Bharatpur.

He suggested therefore :—

- (1) That the agreement of 1837 between the two States should be adhered to. If Alwar considers it is not getting its fair share of water it is open to Alwar to state what steps it wishes to take now to secure it, and to submit its proposals without delay.
- (2) When the Plans and Estimates for the arrangements proposed by Alwar are received, Bharatpur may be asked what objections if any it has to this arrangement.
- (3) If the Agent to the Governor-General approves, a Conference with the representatives, Political Officers and Engineers of each State may then be held, as soon as convenient.
- (4) When all these papers have been received it will be possible to send the case up to the Government of India, with recommendations, or to issue orders.

It is believed the matter is now under the consideration of the Government of India.

Another dispute regarding water rights was with the Jaipur State, known as the Nehri case. This also was referred to the Consulting Engineer, who visited the place with officials from both States. A Note by him on this subject is included in Appendix B of the printed Report. He considers : “As a general rule every village on the banks of a stream has a right to a share of the water, proportionate to the course of the stream through its lands, but no one has a right to obstruct or divert the stream at any time, to the injury of others.”

BANSWARA.

Banswara.—This is one of the smaller States of Rajputana ; the area is 1,606 square miles ; the present population is about 150,000, of which about 93,000 are Bhils. Banswara is the only town ; there are 1,029 villages, of which 461 are Khalsa and 568 Jagir. The average rainfall is 35 inches ; in 1899 it was only 14 inches. Of the total area of the State about half, or 500,000 acres, may be considered culturable ; of this only about half is cultivated. Of Khalsa land 4,000 acres are irrigated, and of this nearly 3,000 acres is from small tanks, showing that the latter are suitable for the country.

The Consulting Engineer made a tour of inspection through this State with Mr. Manners Smith, the Superintending Engineer, accompanied by the Kamdar, Mr. Rao Sahib Gupta, visiting all the sites and old works where it was considered something might be done to promote Irrigation. Plans and Estimates have been prepared accordingly.

The results have been printed and placed on record as a “ Report on Irrigation in the Banswara State,” to which reference can be made for a full description of each Project and the suggestions made.

In dealing with small States like Banswara, Pertabgarh or Dungarpur, one has to consider local conditions and to adapt recommendations to the circumstances and resources of the State. It is of little use to recommend measures which cannot be carried out. The normal revenue of the State is only about Rs. 1,25,000, and the State is in debt about Rs. 2,21,000, the Imperial Government being now the sole creditor.

Almost every village has one or two small tanks near, made by throwing an earthen bund across some depression ; these can be made almost everywhere, and have a very beneficial influence.

The depth of the big rivers, the hilly nature of the ground, the expense, the scarcity of suitable land and of population, are all causes which combine to prevent large works being possible or advisable, and oblige one to fall back on simple recommendations.

Under these circumstances it appears advisable (stated briefly) :—

- (1) Before taking up new Projects to see that all existing bunds are kept in an efficient state.
- (2) To make systematic enquiry into the state of existing wells, and to deepen and repair all that need such action.
- (3) To ensure existing tanks filling every year by increasing surface drainage or diverting any nullah near, so as to prevent water going to waste.
- (4) To make submerged weirs where possible in the nullabs.

For further details see the printed Report.

There is little hope, however, of anything being done, considering the financial condition of the State, without help of some kind from Government; and if any real progress is to be made, it will need a bold and liberal policy.

The remarks made by the Superintending Engineer in paras. 23 and 24 of his Report are deserving of notice. The Consulting Engineer endorses these, and commends them for consideration.

BHARATPUR.

Bharatpur.—This State affords unusual facilities for Irrigation, and the works are of a simple and inexpensive character. They consist chiefly of embankments, with the object of impounding and distributing spill waters from rivers or nullahs near, or the surface flows from local catchments. The country is flat, and the main object is to submerge the land above the bund so as to fertilize the soil by the deposited silt and saturate it for the autumn sowings; further Irrigation is not necessary. Indirectly the works are of great utility in sweetening the often brackish subsoil water and in maintaining the supply of wells.

There is one large Storage Reservoir at Bareta. The catchment area is about 70 square miles; it often overflows, and when full the water spreads over an area of 4 square miles; the maximum depth is 40 ft., and the capacity of the basin 1,500 million c. ft. The influence of this work on the surrounding country is very encouraging.

The chief features of interest, however, in this State are the judicious way in which the inundations of the Ootungun (or Banganga) and of the Gambhir rivers have been controlled, distributed and stored. The Ajan Bund, for example, extends 12 miles across the direction of flow, and is provided with several sluices and escapes.

The floods of the Ruparel are also diverted to the Sikri Bund, an embankment which extends for 12 miles across the country.

Formerly the inundation did so much damage to lands in British territory that they formed the subject of repeated complaint, and the town of Bharatpur even, which is below the level of the Banganga, was always in danger of being flooded.

Now the damage has been prevented, the safety of the city has been secured, and profit is derived from what originally was a source of fear and damage. This is a good object lesson of how a river of this sort may be successfully dealt with, and much credit is due to Mr. Devenish, the State Engineer, who has carried out these works (see para. 17).

Mr. Devenish has prepared a Note on the future requirements and possibilities of Irrigation in the Bharatpur State, which will be of great use.

The Consulting Engineer has had this printed, with a Report he has prepared on Irrigation in this State, which contains many points of interest and notes on each of the places visited, to which reference is invited if further information is desired. The drainage near the town, where the land is more or less water-logged and a supply of good drinking water for the people seem pressing needs.

BIKANER.

Bikaner.—The Bikaner State contains no rivers or streams; the Ghuggar, called also the Sota or Hakra, once flowed through the northern part of the State, but it is now dry. By the construction of head works at Otu, near Sirsa, in the British territory, the water of this river now feeds two canals, which form the most important Irrigation works of the State.

Sometimes superfluous waters from a branch of the Sirhind Canal also occasionally waters a few villages in the north. The rainfall is uncertain, the average being about 11 inches; but in A.D. 1899 it was only 3·6 inches. The State depends entirely on rainfall for its agricultural prospects. Though grass and jungle bushes here and there abound, the aspect of the country is dreary in the extreme.

Trees are rarely seen; but during and after the rains, if they are good, the country becomes a vast pastureland, covered with succulent grasses, and these places are among the best grazing grounds in India.

There is no Tank Irrigation in Bikaner; the tanks are generally small ponds, merely dug out of the ground, and the earth thrown up into an irregular bank; in years of deficient rainfall they do not fill, or soon dry up.

The wells are often 300 ft. or more in depth and the water is sometimes brackish.

There is one feature which appears peculiar to Bikaner. There are depressions among the sand hills, where, after a fall of rain, the surface drainage collects, and owing to the high ground all round does not escape; as the surface dries up, the bed is cultivated and good crops are produced. Whether it is advisable to store water in similar places or to let it overflow the ground below and cultivate the bed as it dries up, is a question which will depend upon local circumstances. If it can be made better use of, either by increasing the supply or by storing it up, measures should be taken to do so. Not a drop of water should be allowed to go to waste or be lost to the State; but it is not advisable to spend money in storing water if it is already made good use of.

Every jhil and every watercourse in the State should be systematically investigated, numbered and entered on a statement for record.

It is possible something may be done in the way of shallow embankments (*para. 19 of the printed Report*), but for the greater part of the State, a more hopeless country for Irrigation it would be difficult to find.

The Consulting Engineer and the State Engineer, Mr. Standley, visited the following places together:—

Madh, Pilap, Chandni and the Talwara swamp and the Ghuggar south canal. The Maharaja of Bikaner, who takes a keen interest in all that concerns the welfare of his State, especially Irrigation, came with us to

several places. A Note on every place visited was prepared by the Consulting Engineer and is included in the printed Report.

The most important proposal, however, is to get a canal from the Sutlej.

Just outside the north-east corner of the State all the country in British territory is covered with a network of canals, which all stop at the Bikaner border. The demand for water is so great that not a drop can be spared for the Bikaner land.

At Suratgarh, about 100 miles north of the Capital, the character of the country changes—the ridges of sand and desolate waste are left behind, and one enters on a flat alluvial plain. Here and there one sees mounds covered with old red broken bricks and pottery, the soil is better, and when there is a normal rainfall the flat area for miles is cultivated and yields a good harvest.

One sees also clearly defined, but a few miles apart, the dry beds of former rivers, all sloping to the west. These facts show that the whole country in former times was well inhabited, and was watered by rivers from the north-east, which are now lost in a sea of sand in the direction of the Run of Cutch.

It is clear that if water could be again induced to flow here, there is no reason why this area should not be one of the best cultivated parts of India, and a great part at least be restored to its former prosperity. It is worth investigation at all events.

Mr. Standley (the State Engineer) has had trial lines of levels taken as far as Ferozpour, and finds the floods in the Sutlej at this point give sufficient command to irrigate fully 500,000 or more acres of land in the Bikaner State.

What Bikaner requires is to get flood water at any cost, so as to be able to develop a large tract of country in the north, now laying absolutely uncultivated and undeveloped.

In the rains there is the River Sutlej passing by, and volumes of water are flowing to the sea; and here thousands of acres of land are waiting for water, water which if it could be brought here would make famine in this region impossible.

The Note submitted by Mr. Standley shows that he has seen the importance of this Project, and has done all he can to bring it forward.

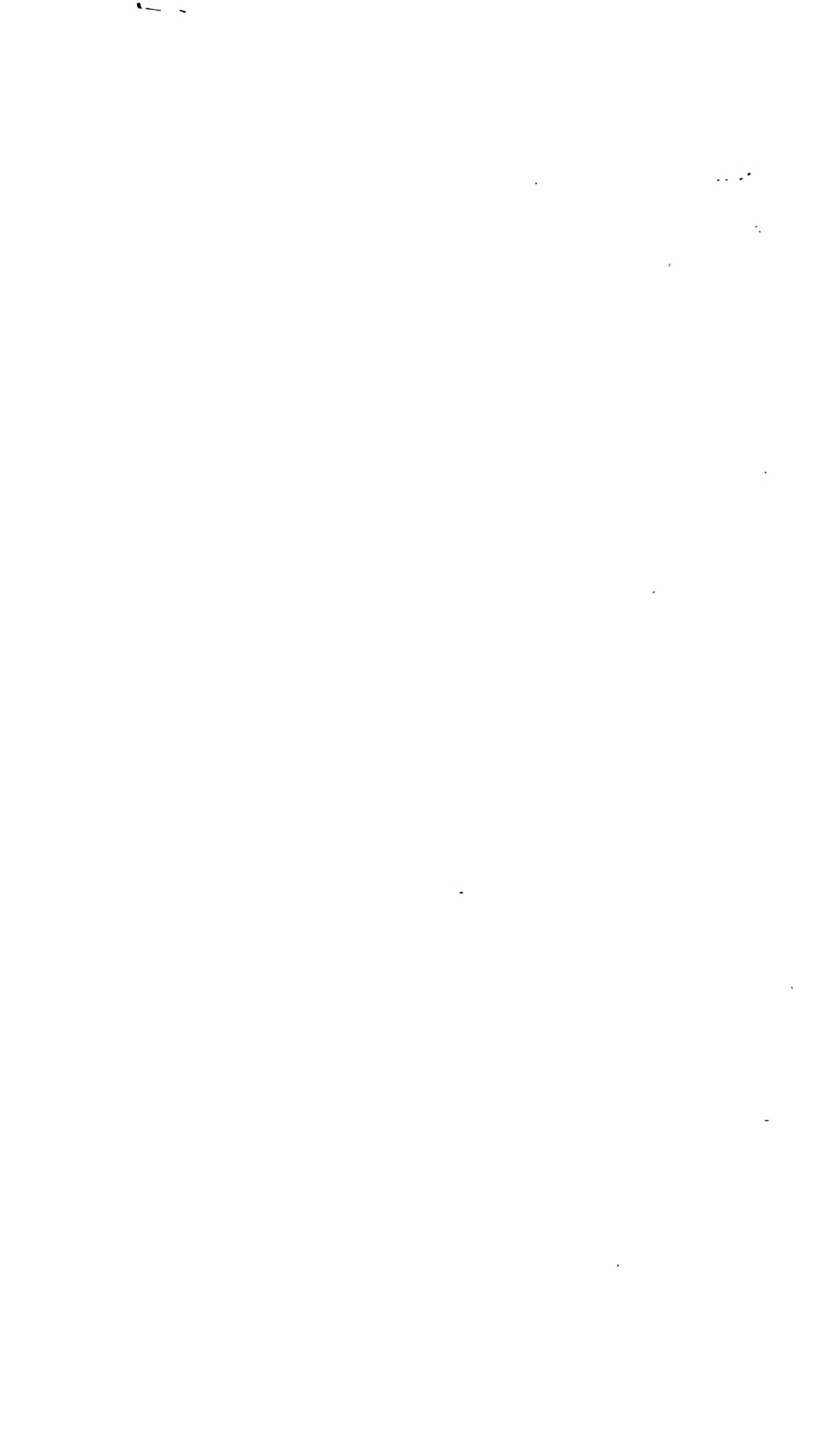
The questions now are : Which is the best route the water shall take? Shall it be an inundation canal or what? Can water be stored anywhere?

The whole question requires to be investigated by a body of expert Irrigation Officers.

The Bikaner State, however, is not in a position to undertake the surveys in British territory, or to prepare a large Project of this sort. The Bikaner State can do no more than it has done, but it is willing to bear the cost of the investigations. It is here that the Imperial

Government can come forward with a helping hand, and there is no one else who can do so. It appears to be the only hope of anything really being done in the way of Irrigation in the Bikaner State.

The whole subject has been so fully dealt with in the printed "Report on Irrigation in the Bikaner State," by the Consulting Engineer, that it is unnecessary to say more here. A perusal of that Report is invited. The selected evidence given before the Irrigation Commission by some of the best officers in the Punjab Irrigation Department, is very strong on the possibility and advisability of making more use of the waters of the Punjab rivers, and alludes to the Sutlej in relation to this proposal. The subject is earnestly commended to the consideration of the Government of India.



BUNDI.

Bundi.—The State is admirably suited for Irrigation, and the greater part of the culturable land can be commanded. At present an enormous volume of water passes away unused, and this water is money lost to the State. A central range of hills divides the State. In the northern half the problem was to find sites for storage of water where there is a good catchment area, with good land commanded; in the southern half, to find sites for storage of water where the rivers leave the high sand-stone plateau, where they can be controlled, and where the catchment is suitable for a large percentage of run-off, and from which there is a good command of the rich culturable plains below.

Irrigation has not hitherto been developed in the Bundi State, and although famines fortunately seldom occur, yet during the recent famine the State lost about 42 per cent. of its population. Scanty population will no doubt limit Irrigation, but in time this ought to improve: and to provide water is the best way to secure this result. Wherever water has been judiciously stored the benefits are apparent.

Another feature in the Bundi State is the submerged weir. There are several built across nullahs to hold up a few feet of water. In the rains the floods pass over, and afterwards the water which is stored is raised to irrigate lands on both banks, and by percolation benefits the adjacent wells and springs below. This system, it is believed, might be extended with advantage. The Consulting Engineer inspected most of the sites proposed for Storage Reservoirs with the Superintending Engineer (Mr. Manners Smith) and made a Note on each. It was suggested that in all these schemes the opinion of the Revenue officials should be taken. Mr. Manners Smith has now completed his investigations, and has submitted a printed Report giving the results. Seven large Projects are proposed and ten smaller ones; and when these are carried out, the greater portion of the culturable land will be commanded.

Anyone looking at the map at first sight would notice the Khatgar Gorge, where the River Mej passes through a rocky gorge in the Aravalli range, about 500 ft. only in width, as a likely place to put a dam and make a grand Storage Reservoir, but after investigation it had to be given up, for the reasons stated in the printed Report (page 5, para. 14).

Copies of Mr. Manners Smith's Report were sent to the Bundi Durbar, and in the letter from the State Council (No. 403, dated 1st October 1904) to the Political Agent, acknowledging them, the following passage occurs:—

“The contents have been read out to H. H. the Maharao Raja Sahib, who has directed us to ask you to kindly convey his thanks to the Honorable the Agent Governor-General for the Irrigation Reports.

"His Highness takes the greatest interest in the matter of Irrigation, and we would therefore request you to kindly ask the Consulting Engineer to have detailed Plans and Estimate prepared of all the Projects mentioned in the Report, on receipt of which we shall be glad to decide as to which of the works should be taken up first."

It is satisfactory and encouraging to see the interest awakened. Let us hope it will bear fruit in due time.

Nine Projects have been drawn up, printed and submitted.

Seven smaller ones in addition have been suggested, but have not yet been surveyed; nor does it seem necessary, as those that have been worked out will be sufficient for many years to come.

If financial difficulties now prevent anything being done, it is to be hoped some means will be found to overcome them.

DHOLPUR.

Dholpur.—The area of the Dholpur State is 1,193 square miles. The population is 279,724. The Khalsa villages number 419, and comprise about 75 per cent. of the whole area. The average rainfall is about 25 inches.

Tanks irrigate a very small area—from State Tanks, only about 2,041 acres.

The first attempts appear to have been made in the times of the Mohammedan Emperors. Since that period, with the exception of a few repairs, nothing has been done, owing to the financial condition of the State, until 1896-97, when the necessity of employing famine labour caused a few tanks to be made, on hurriedly-collected data.

At present the chief source of Irrigation is wells. In Khalsa lands there are 4,501 and in Jagir 376; total 4,877 pucca wells. There are 8,166 kutchra wells in Khalsa.

31. Tanks as Irrigation works have been proposed by Mr. Thorpe, the State Engineer.

At the end of A.D. 1902 the Consulting Engineer made a tour of inspection with him, and drew up a Note on each of the principal Projects on which his opinion was desired; and in March 1905 he inspected the different sites on the River Parbati, where his opinion was desired on different sites which were proposed for Storage Reservoirs on this river. These Notes have been printed and placed on record.

It would be difficult to find a State better adapted for making storage tanks; almost every depression near a village can be made use of; many examples exist already where the villagers have thrown up earth, generally faced with stone, to collect water in the rains. After the rains when the water is let out, the bed, which would not exist but for this small bund, is cultivated, and perhaps a patch below the bund also. The rocky nature of the ground ensures the Tal filling even with a small fall of rain, and the water stored helps to supply the village well, which otherwise would perhaps be dry.

There are no perennial streams flowing through the State with the exception of the River Chambal, which forms the southern boundary; its bed is about 130 feet below the level of the surrounding country, and the banks are intersected with ravines which spread out to the foot of the hills of red sandstone, which rise some 500 feet above the plain. There seems to be no hope at present of utilising the River Chambal.

The bare rocky range of hills at the highest part of the State, however, affords great facilities for Irrigation; nature could not have

arranged better for the interests of Dholpur. Any water stored here commands all the land to the east, the whole State in fact, and if stored in sufficient quantity would make it safe against famine.

Since the first visit of the Consulting Engineer, one of the largest works proposed then, Seheri (now called Ram Sagar after the Ruling Chief) has been begun, and is about half completed. The State Engineer (Mr. Thorpe), who takes a keen interest in Irrigation, and the authorities are evidently doing all that is possible to promote Irrigation.

DUNGARPUR.

Dungarpur.—This is one of the smaller States of Rajputana. It has a total area of about 1,400 square miles; for the most part it is a network of rocky hills and small valleys. The population according to the census of 1901 was 100,103, of which 33,887 were Bhils. The average rainfall is 25 inches, but it varies much. In 1899 it was only 10·29.

Irrigation is carried on from small tanks, and from wells. There are about 2,500 wells in the State, of which 800 are not used, being in need of repair, but the authorities seem to be alive to the value of wells, and 105 are now being deepened and repaired. There are said to be 134 breached tanks in the State, and, in consequence, all the land in their beds and commanded below is at present lying idle, and only a portion is cultivated in the Kharif.

The revenue of the State is under a lakh of rupees, and the debt is about Rs. 3,10,000, now due to the Imperial Government, which has taken over the debt to help the State. Nearly all the Sirdars are said to be deplorably embarrassed, and the cultivators to be generally in debt.

The hilly nature of the country, the depth of the large rivers, the small population, and the financial condition of the State make it impossible to take up any large Project. At the same time the soil is so good and retentive that in years of normal rainfall, irrigation is not necessary. It is only when the rains fail that the difficulty about water occurs.

There are about 340 small tanks, of which 206 are said to be in use, showing that the people in former days at all events recognised the value of storing water and the suitability of tanks to the country. The repairs of existing tanks and wells appears to be the work most necessary.

The Consulting Engineer made an inspection of this State with Mr. Manners Smith (Superintending Engineer), accompanied by the Kamdar of the State, and visited every place where it was thought something might be done. His suggestions and the result of Mr. Manners Smith's investigations have been printed and placed on record for further information. A reference to that Report is requested.

JAIPUR.

Jaipur.—The number of Irrigation works in the State completed or in progress is 202. The total length of main ducts from 5 to 20 ft. is about 750 miles and of distributaries about 700 miles. For the Raj official year ending 31st August 1904, on Irrigation works the total expenditure has been Rs. 1,74,439. Although the rainfall was deficient in the western districts, where many of the tanks only partially filled, in the remainder of the State it was good, and the revenue realised has exceeded previous records. The total area irrigated was 38,938 acres.

The amount due to water rate only was Rs. 1,04,296			
Share of produce	...	...	„ 3,00,274
Total			„ <u>4,04,570</u>

Not bad for one year.

The total expenditure on Irrigation, both on new works and on repairs, through the P. W. D., from A.D. 1868 up to 31st August 1904, has been Rs. 66,86,500, and the total estimated returns Rs. 58,89,159; so that if no further expenditure occurred, in 3 or 4 years all the money laid out would be realized, and a revenue of about 4 lakhs be received annually from Irrigation. One of the latest works, the big sand dam which was built near Ramgarh, and forms a lake called Crosthwaite Sagar, at a cost of Rs. 5,20,601, last year filled to 43 ft., and although only in its third year gives now a return of 12·72 per cent., which is very encouraging.

These facts ought to encourage other Native States. The investigation of sites for new tanks has been actively carried out. No less than 34 different Surveys were carried out under Mr. Stotherd's supervision during the year, in connection with new or existing Projects.

The map which accompanies the Report on Irrigation in the Jaipur State shows in colour the progress which has been made and how much still remains to be done. The results of previous expenditure have been so good that it is hoped the Durbar will be encouraged to continue the same liberal enlightened policy.

There are several points of interest connected with Irrigation in the Jaipur State, such as the large dams of sand which have been successfully made; the value of canals as supply cuts in the rains; the benefits of bunding up cross drainage, &c., which have been alluded to more fully elsewhere.

The above remarks show that the Superintending Engineer of the Jaipur State (Mr. C. E. Stotherd) is fully alive to the importance and benefits of Irrigation, and much credit is due to him and his staff for the good work done lately and so well maintained.



JAISALMER.

Jaisalmer.—Jaisalmer forms a part of what is known as the Great Indian Desert. The area of the State is 16,447 square miles. With the exception of a small area within a circuit of about 40 square miles near the capital, where sandstone occurs, the general aspect of the country is an interminable sea of sand-hills. Water is scarce and generally brackish, and the average depth is between 200 and 300 ft.

There are no perennial streams, and only one small nullah called the Kakni. The revenue is about a lakh or so a year.

Advice was given by the Consulting Engineer in 1903 on 3 or 4 small Projects, and the Resident, Western States, Rajputana, was asked lately (1905) if there was anything we could do to help the State in Irrigation matters. In reply he stated "that Jaisalmer was confronted with another bad year, and it is a problem to find sufficient money to carry on the bare administration, so that even the most modest Project in the way of Irrigation or repairs to existing works are out of the question.

"No attempt is being made to provide relief by famine works, as it is realized that it is better to allow the people to leave the country than to induce them to remain until too late. The deficiency of water even for drinking purposes is the difficulty."

The Resident, however, reported the offer of assistance to the Diwan of Jaisalmer, who replied that the State Overseer has nothing this year on which he might ask advice.

The Agent to the Governor-General, Rajputana (Sir A. Martindale), in January 1905, wrote that as far as he is aware no expert has ever examined the potentialities of Jaisalmer from an Irrigation and water storage point of view and having regard to future possible action; when the present cycle of famine years has passed, he would be glad to know if Jaisalmer presents any openings for works of that description, either by extending the existing system of shallow tanks called *kharims* or by tapping the deep subterranean water sources which are said, albeit on doubtful authority, to be practically inexhaustible; or by such other means as might suggest themselves.

The Consulting Engineer doubts if anything reliable can be expected from *kharims*, owing to the uncertain and small rainfall; and as regards any supply from wells, owing to the great depth, even if the supply was abundant, he fears it would be prohibitive as a remunerative work. He stated that he knew very little about the conditions prevailing in that part of Rajputana, but he was ready to go there and investigate the matter if desired.

In the meantime he had some correspondence with Messrs. Enever Bros. of Lucknow on the subject of deep wells (see para. 31).

JHALAWAR.

Jhalawar.—The facts which strike one on visiting this State are :—

- (1) The great extent of good land lying fallow.
- (2) The many excellent sites that exist for storing water in almost every part of the State.
- (3) The quantity of water which annually goes to waste.
- (4) That water can be stored cheaply ; and under good conditions it brings in a good return.
- (5) The serious loss which the State has suffered both in population and cattle owing to the recent famine.
- (6) The difficulty in getting people to take up land.
- (7) That the resources of the State are very limited, and that without help there is little hope of anything being done.

There is no hope of large Irrigation Projects at all events being carried out at present ; but there is no reason why smaller schemes should not be prepared : and while some are being carried out, the surveyors could be employed in preparing others. This appears to be the first step necessary. If any of the streams can be tapped so as to ensure tanks being filled every year, then they will be a help against famine for the villages under their influence. This is what should be aimed at ; and although not a complete insurance, they will go some way towards ensuring a better supply to wells below, and in giving the people a better power of resistance. [See remarks by Consulting Engineer, Appendix XVIII, on diverting small nullahs to places where the water might be stored.]

Time did not admit of the Consulting Engineer investigating every drainage area and searching for sites when he visited Jhalawar in January 1904, but he inspected the places where his advice was desired ; and besides writing a Note on each work, he prepared a Report on the subjects of Irrigation generally, in the Jhalawar State, which was printed for record, and has already been submitted. The following is a brief summary of the suggestions made :—

- (1) The need of financial help, a problem to be solved by the Political Officers and the Durbar.
- (2) A fixed sum to be set apart annually for Irrigation and to be used only for this purpose.
- (3) Surveyors and establishment to systematically prepare small Projects at first, in consultation with the Revenue officials. While these were being carried out, the surveyors to be employed in preparing other Projects.

If proper provision is to be made against famine such measures would be necessary in any case.

- (4) As these Projects are prepared they should be registered, the bench marks be made permanent and records kept ready, to admit of work being started without doubt or delay at any moment.

The sort of works recommended are :—

- (1) Repairs or improvements of existing tanks.
- (2) New village tanks where the need and benefit of making them is admitted by all.
- (3) The diversion of watercourses to fill existing or proposed tanks.
- (4) The improvement or extension of ducts to existing tanks, so as to increase the value of water already stored.
- (5) The improvement of pools in rivers to increase the supply of water to wells below.
- (6) The deepening of existing wells wherever necessary. Information to be called for.
- (7) The construction of new wells below tanks wherever necessary.
- (8) The construction of submerged weirs across watercourses at suitable sites.

It was suggested that separate accounts of all works carried out should be kept, showing original cost, the amount spent on repairs, the area and crops irrigated and the amounts realised annually, and that the State if it really did its best, would, for its own credit, be glad to show the progress made each year.

The above remarks are applicable more or less to every State. Since then, under instructions from Government, Mr. Manners Smith has visited the State, and has investigated every drainage area, and submitted a Report showing what are the possibilities in the way of Irrigation. Some of the best Projects are now being prepared under his supervision.

JODHPUR.

Jodhpur.—Jodhpur, also called Marwar, contains an area of about 34,963 square miles. It is the largest State in Rajputana.

The country to the north is one vast sandy plain broken by ridges of sand-hills. In the Mallani District these sand-hills rise to a height of 300 feet or so, and the country resembles an undulating sea of sand. In these districts water is scarce, and from 200 to 300 feet below the surface.

The most fertile parts are Godwár, Soját, Jetáran and Mároth. In these districts wells abound, and spring and autumn crops are grown. In the sandy tracts a small rainfall suffices for the crops; the sand-hills are ploughed by camels, and sown; the desert camels are quick movers and enable a large area to be cultivated. If the season is good, more grain is produced than is needed for the wants of the people, and the surplus is frequently left on the ground as fodder for cattle. If the rains fail there is distress. It is under such circumstances that Railways do so much good, and the Jodhpur-Bikaner Railway has been the saving in both States of all the country within its influence.

The population at the last census was 1,935,563. The rainfall is very uncertain; in ordinary years it ranges from 12 to 18 inches, but falls sometimes much lower. This shows the desirability of making large Storage Works when they can be made at reasonable cost, to store the water of good years, to help make up for the deficiency of bad years.

The dryness is due to the geographical position of the State. The country is beyond the range of the full force of the south-west monsoon from the Indian Ocean, and out of the full influence of the south-east monsoon from the Bay of Bengal.

Another difficulty is that the greater part of the land is in Jagir. Out of 3,500 villages in the State only some 700 are said to be *Khalsa*, and the Jagirdars are most of them, it is said, in debt. They cannot afford to initiate work, even if they had the wish to do so, and do not care to share work with others which might benefit all.

The Aravalli range of hills run along the south-east portion of the State for some distance, and the whole country slopes from this range in a westerly direction towards the Run of Cutch, affording many excellent sites for storage of the water, which runs from this range to the sea.

Mr. W. Home, now on leave, who has been State Engineer as well as Manager of the Jodhpur-Bikaner Railway for some years, has done good work in making Storage Reservoirs and in suggesting others.

The Consulting Engineer visited some of these places with him in 1903, and submitted a Note on Irrigation in the State, making suggestions which the Durbar are endeavouring to carry out. One of these was that a special officer should be appointed to look after State Engineering work and Irrigation specially, as the Railway management has grown to a system covering a length of 800 miles to Sindh and Bikaner, with large locomotive and carriage workshops, and was more than enough to occupy the time and attention of one man.

When Mr. Home went on furlough the Durbar appointed Mr. deClosets as State Engineer, and the Consulting Engineer has lately (1905) been on tour with him. A printed Report has been submitted in which details of these tours and the suggestions made are noted. Beyond alluding to two or three interesting Projects it will be unnecessary to say more here.

The large catchment area, the good sites for storage Reservoirs and the large amount of water which can be stored per rupee, are points that strike one and give encouragement. There are large areas of land at present lying uncultivated, and there are not sufficient people to take up the land; but liberal terms to settlers and the storage of water which now goes to waste, are the best means to remedy these drawbacks.

The proposal to make a large Storage Reservoir on the River Jowai, alluded to in the printed Report, if found to be feasible, seems to be well worth doing; it would store the drainage of about 390 square miles of hilly catchment, and would irrigate many square miles of good land near the line of Railway, most of which is now lying uncultivated.

One matter of interest in connection with Irrigation in Marwar is the effect which bunding up the Luni has had on the country below, alluded to in para. 42 of the printed Report.

The catchment area is about 1,300 square miles, the contents when full about 3,800 million c.ft., the surface area when full about 22 square miles, the greatest depth 40 feet, the total cost Rs. 904,394.

When it was proposed some years ago to make this reservoir, it was feared doing so would injuriously affect those lower down, who depended upon the floods, but from enquiries made in villages along the river bank the report received was that more benefit than harm had been derived. The details of these enquiries are noted in the printed Report. Mr. Home sums up thus: "It may be assumed that in good years Jeswant Sagar influences favourably the water supply in wells along the river banks for about 100 miles down stream, while in bad years it can affect them neither one way nor the other."

Further information regarding the different Projects proposed will be found in the printed Report on Irrigation in the Jodhpur State.

KARAULI.

Karauli.—The area of the Karauli State is about 1,260 square miles. The whole State may be said to be divided into a number of ridges running from north-east to south-west, consisting of a series of parallel ranges of low hills, with small and narrow valleys in between them. The widest range is the one next to the River Chambal, locally known as the Dang; its width varies from $1\frac{1}{2}$ to 12 miles.

The general characteristics are: existence of rock, consequent want of soil and water; and as a result in these parts a barren and unprofitable soil.

The fields are in terraces, formed by small bunds locally known as *pokers*, and the flood waters flow from one to the other in succession.

The valleys generally consist of from 10 to 30 feet of loose sandy soil overlying a bed of stiff clay mixed with kankar. The top soil is extremely fertile if water can be supplied to it. Owing, however, to its loose composition and to the velocity with which water from the higher ground descends, it soon cuts away, and ravines are formed ranging from 10 to 60 ft. deep. The effect is to drain the country and lower the level of the sub-soil water, and gradually to reduce the area of good land.

Mr. Housden, who was Executive Engineer in 1884-86, submitted a very complete Report, showing 79 Irrigation works, with sketches and approximate estimates. The largest (Durgasi) was estimated to cost Rs. 450,000; the Gotra Tank Project, Rs. 75,000; and the Nindar Project, Rs. 45,000. Mr. Housden recommended the last two to be taken up first, and detailed Plans and Estimates were prepared for these.

Mr. Devenish, who was State Engineer at Bharatpur in 1901, made an abstract of Mr. Housden's Report, and prepared a list, giving the estimated cost, area irrigable and probable returns.

Owing to the interest taken in the subject by Col. Herbert, who was Political Agent, these Notes were fortunately rescued from oblivion, and have now been printed and placed on record.

Mr. Gatherer, who was Superintending Engineer for Rajputana in 1885, and Col. Gordon Cumming, R.E., who was also Superintending Engineer in 1886, both made Notes on these Projects.

These papers have all been collected, printed and placed on record by the Consulting Engineer for Irrigation in his Note on the Karauli State, dated April 1904.

No progress appears to have been made, however, owing perhaps to the financial embarrassment of the State, and the subject appears to have

dropped. In April 1903, the Consulting Engineer pointed out that owing to the completeness of Mr. Housden's reconnaissance any further preliminary investigation appeared unnecessary, and expressed his readiness, if the Karauli Durbar wishes to take up any of these Projects, to inspect them with Mr. Manners Smith, the Superintending Engineer, and to help them in any way in his power.

The Durbar replied on the 24th August 1903 that they were expecting an Overseer "very shortly to begin the work of investigation of Irrigation Projects" (unaware apparently of what had been already done), "and a report would be submitted, stating the points, should there be any on which he considered the assistance or advice of the Consulting Engineer was necessary."

No report has been received up to this date (April 1905). Under these circumstances no further action on our part seemed advisable.

A reference to the printed papers in connection with Irrigation in Karauli, submitted by the Consulting Engineer in April 1904, shows what might be done, and some day perhaps will be done, to store some of the water which now goes to waste, and so benefit the State.

KISHANGARH.

Kishangarh.—(1). Each drainage area has been investigated by Mr. Manners Smith, and nearly all that there is to be done in the way of storage and protective works has been done. The Durbar seems to be fully alive to the value of the water which passes through the State.

- (2). Although the average Land Revenue is said to be only about Rs. 2,05,000, yet in the last 30 years the amount spent on Irrigation is stated to be Rs. 7,30,000, an average annually of $\frac{1}{8}$ th of the revenue.
 - (3). The total yearly return on this outlay is said to be about Rs. 1,32,000, which, if correct, represents about 16 per cent. This ought to encourage other States.
 - (4). Dams or Weirs have been made across almost every nullah, and the idea of not allowing any water to pass out of the State to waste has been steadily carried out; in fact so much has been done that it has caused remonstrance from the Commissioner, North-India Salt Revenue, lest the supply to the Sambhar Lake should be interfered with; and from the Jaipur State that existing Irrigation Works in that State did not get their fair share of water.
 - (5). The procedure adopted in the Kishangarh State to encourage the cultivators to make wells and in giving advances, as described in para. 33, is deserving of notice.
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KOTAH.

Kotah.—The following is a brief summary of the main points to which attention is invited as regards the Kotah State, page 17 of the printed Note by the Consulting Engineer.

- (1) The letter from the Diwan of the Kotah State (No. 134, dated the 16th September 1901, to the Political Agent, Kotah), shows the past experience of Irrigation in this State and deserves careful attention (*see page 23 of the printed Note on Irrigation in the Kotah State by the Consulting Engineer*). Briefly, he is of opinion that the black cotton soil does not want irrigation, and that whatever value large Irrigation works might have in times of famine, in ordinary years they would yield but little profit.
- (2) In the Kotah State officials consider it would be better to spend money in making wells.
- (3) Field embankments for retaining small quantities of water are sometimes made, and in light soil are beneficial, but are rare in black soil, which retains moisture better, and has less need of such measures.
- (4) Tank or canal Irrigation seems to answer better where there is not black soil; in places where the soil is mixed with sand, water seems to be appreciated, and there is a good return. *Pila* soil without water is said to yield from 2 to 3 maunds, but when irrigated to yield sometimes as much as $7\frac{1}{2}$ maunds; black soil without water is said to yield about 4 maunds, but with water $5\frac{1}{2}$ maunds. If this is correct it shows that water does produce benefit even on black soil, but that it is better to supply water to *pila* soil than to black soil. It would be advisable, therefore, to have those tracts marked with colour on the map, and to direct attention to them first.
- (5) A great part of the State is black soil, which if broken up retains moisture longer than light soils; so much so that in the Kotah State large areas are shown with "katha" wheat; if the rainfall is timely the crop requires no further watering, the only labour then required being to guard the field. The ease with which vast areas of wheat are thus matured in years of average rainfall, tends to make the people indifferent to irrigation and averse to labour, excessive rain damages the crop, and water would only be appreciated in those years when the rains hold off at the latter part of the season.

The peculiarity of the "katha" wheat is that it can be matured on the rich black soil without watering; timely rain is all that is required, and although the yield is said to be not so great, the ease with which it is matured makes it more popular than other kinds of wheat.

- (6) Full use is not made of the large quantities of water which flow in the rivers during and after the rains, nor in some places of water which has been stored.
- (7) The reasons given are that the water (1) by percolation benefits their wells and also is wanted for the cattle, (2) that the tanks are not large enough to supply water for both the above and for irrigation, (3) that black soil does well enough in ordinary years without irrigation, and (4) that if water is taken the land tax will be increased.
- (8) It would be advisable in every instance to find out how far these reasons are real, for in A.D. 1900 in one place although water was available they trusted to the rains, and half the *Kharif* crop it is said withered.
- (9) The cutting back by ravines every year is becoming a serious matter. This is alluded to in para. 10 of the printed Report on Irrigation in the Kotah State, and in para. 38 of this Note.
- (10) As regards the Parbati Canal, at present only from 11 to 17 per cent. of the area commanded is said to be irrigated by the canal and its branches. At the same time the whole of the water is not made use of; about one-fourth is allowed to run to waste up to December, and then there is not enough water to meet all the demands. Far more use might be made of this work.
- (11) It appears desirable that :—
 - (a) Water which goes to waste now should be stored, either at the head or at suitable places near the line of canal, and as near as possible to the land where it is required.
 - (b) The canal and distributaries should be so designed as to ensure enough water being available for the irrigation of all the land which will take it *within the time limited for the first watering*. It is no use to offer water when it is too late to use it.
- (12) This subject is more fully dealt with at page 42, Appendix of the printed Note on Irrigation on the Kotah State by the Consulting Engineer, to which reference is invited.

(13) The following is a summary of the main points to which attention is invited as regards the Kotah State. See page 17 of the printed Note by the Consulting Engineer :—

- (i) The country is admirably adapted for large Storage Tanks. It is possible to make them, and only such works as have an unfailing supply of water can be considered really protective, but the magnitude of such works makes it advisable not to begin them until Plans and Estimates have been approved and the necessity is clear.
- (ii) In the meantime advantage might be taken to construct smaller works on the poorer soil, or in such places where it is certain the water will be used ; and where there is the certainty of their being filled every year, either from their own catchment or from rivers or nullahs near.
- (iii) The advisability of utilising, where possible, the running water in rivers or streams, either to fill existing or proposed tanks, or by making submerged weirs to form pools in such places as will enable wells at the side or below to be used for cultivation of land on the banks, and where stone is plentiful and no expensive foundations will be required.
- (iv) The greater benefit to the country generally by carrying out such works, instead of large and grand storage schemes which require years to prepare, to make, and to develop, and where the expenditure will be all in one place.
- (v) The advisability of preparing Plans and Estimates for works that will irrigate lands situated on other than black soil, and only in such places as are approved by the Revenue officials and the villagers concerned, who should always be consulted.
- (vi) The advisability of completing work already constructed but incomplete, such as the Rarbati Canal, which requires storage tanks to do its full duty and to make it a success. This is one of the first duties the present State Engineer (Mr. Devon) proposes to undertake, and he is quite right.
- (vii) If not already done, a list should be prepared showing every tank, the quantity of water it will contain at every foot in depth, and the corresponding area which could be irrigated if the water is properly used.

This is a good check upon the use made of the water.

- (viii) The Revenue officials always take some guarantee from the villagers before a work is constructed that will ensure a fair return for the outlay.

- (ix) The need of better supervision by some qualified person to ensure the progress of Irrigation.
- (x) The necessity for canals to be large enough to ensure a regular, full and prompt supply of water, sufficient to irrigate all the land requiring water within the time limited for the first watering, say 30 days.
- (xi) A liberal policy as regards the construction of wells, as the water is generally near the surface and the supply good at all times; especially to have wells below existing or proposed village tanks. (See opinion of the Revenue Superintendent, para. 24c). Wells made in A.D. 1900, it is said, give a good profit.
- (xii) The need of a fixed policy, if progress in Irrigation is desired (1) in the preparation of Projects; (2) in carrying out of Projects. (See para. 19). A liberal grant to be set apart annually, and work once sanctioned to be vigorously carried out to completion.
- (xiii) An Annual Report to be submitted showing the progress of Irrigation in the State. It should be printed to facilitate reference and record. It should contain a brief account of any Surveys made or Projects prepared during the past year.

The following facts should also be noted :—

- (1) The rainfall.
- (2) The amount spent on Irrigation during the past year, including all charges.
- (3) The total area irrigated.
- (4) The total amount realised by the Revenue Department for water rate, or whatever may be due to Irrigation.

If these are noted in graphic diagram form, one page will contain all the above information, and will admit of being added to every year, and it will form an interesting record.

Where a State or an officer has made efforts to promote Irrigation, the opportunity to show this record will be gladly taken and appreciated.

- (xiv) Irrigation has not hitherto been as successful as it ought to have been, because some of the points noted above have not been fully attended to. There is not the slightest doubt that Irrigation will be a success if it is properly carried out as suggested, and if it is taken up with heart and soul.

The progress and the results of Irrigation will depend upon the real interest taken in the subject by the Durbar and by all concerned.

The present State Engineer (Mr. Devon) is ready to do all he can. For further information reference is invited to the detailed printed Report on Irrigation in the Kotah State, where notes will be found on every Project in detail.

Many of the points noted here are applicable to every State.

MEWAR OR UDAIPUR.

Mewar or Udaipur.—The need for Protective Irrigation is as great in this State as anywhere. No State in Rajputana has better natural advantages. Several large rivers rise and flow through the State, affording opportunities for storing water.

The formation of tanks for this purpose and as relief works is not a new idea. Some of the finest artificial lakes in India exist in Mewar, though not intended mainly as Irrigation works.

The Raj Samand, built in A.D. 1661 “to alleviate the miseries of a starving population and make their employment conducive to national benefit,” is said to have cost 96 lakhs, contributed by the Rana, his Chiefs and rich subjects.

The Jai Samand is another magnificent lake, with an area of about 20 square miles, built in A.D. 1681-1700. It perpetuates the name of Maharana Jai Singh.

These two examples and the four lakes near the Capital, including the Fateh Sagar, which was made by the present Maharana, are sufficient to show what grand works have been carried out by the Chiefs and people of Marwar.

The difficulties which have to be met are : the small area (4,000 square miles of Khalsa land compared with 9,000 square miles in Jagir and Muafi) and the rights possessed by the owners. Two-thirds of the total area is hilly and unproductive. The benefits, too, of Irrigation have not yet, perhaps, been brought home to the Chief or the people, as these lakes were not made so much for Irrigation, and there is an objection in the native mind to use up water which has been stored for other purposes ; but the main difficulty is probably the want of funds to carry out any large work. This is a most serious difficulty.

All the principal rivers, however, have now been investigated, and sufficient information has been obtained to show where work can be taken up, so that no time need be lost nor uncertainty exist as to what to do. The results have been printed in the form of a “ Note on Irrigation in the Mewar State.” Each of the main rivers—the Khari, the Mansi, the Kothari, the Banas, the Berach, the Bagan, and the Gomeri are all dealt with.

It is impossible in a brief abstract like this to enter into a description of these rivers, but a reference to printed records will show how thoroughly the matter has been dealt with.

The officers entrusted with these investigations naturally turned to see if anything could be done with the River Banas, the largest river in Rajputana. This has been carefully examined, and a site where it was thought a good storage reservoir might be made, was inspected and approved by the Consulting Engineer in March 1903.

This Project has been prepared under the supervision of Mr. Manners Smith, Superintending Engineer, and a complete Report, with Plans and Estimates and details of this interesting Project, have been printed in book form and placed on record, and it is hoped will meet the expectations and approval of the Government.

The unintercepted catchment area at Amarpura, the site of the proposed dam on the Banas, is 5,000 square miles. The total length of the dam will be 4,165 ft., of which 3,158 will be of masonry and 1,247 ft. will consist of earth with a masonry core-wall.

The heights proposed are as follows, taking the bed of the river as R. L. 505 :—

Level of weir	...	...	...	572
Full supply level	...	...	...	580
Flood level	...	...	...	585
Crest of the dam	...	...	...	593

It is not possible to have the flood level higher than R. L. 585 without damaging some large villages.

The river at the site of the dam is only 720 ft. wide, with rock on both banks and in the bed. Borings were taken across the river bed; and in the printed Report a plan is given showing where these were taken and the depth at which rock was found, a good foundation on rock being absolutely necessary. When the lake is full the water will spread over an area of about 30 square miles, most of it waste land; and the capacity will be 15,676 million cubic ft. Allowing 100,000 c.ft. per acre, inclusive of absorption and evaporation, there will be water sufficient to irrigate about 156,767 acres, or about 245 square miles.

It is proposed to have 28 under-sluices in the masonry portion of the dam across the river bed. These will be similar to the sluices in the Assuan Dam on the Nile; they are fitted with Stoney's Patent Gates, each 25×5 , spaced 20 ft. clear apart. These do not fit tight against the masonry but hang freely against a series of ante-friction rollers, which admit of their being easily worked from the top of the dam.

In addition to discharging and controlling a portion of the flood water, these under-sluices will prevent the accumulation of silt in the bed of the reservoir, and will also discharge the water required for the low-level canal, the head works of which will be about 10 miles lower down the river on the right bank.

With an open weir it would only be possible safely to store water up to weir level R. L. 572, but by adopting Viswaray's automatic flood gates, similar to those in use on the waste weir of Lake Fife, near Poona, it will be possible to hold up 8 ft. vertical depth of water, above the level of the escape. It is proposed to put 104 of these automatic gates each 10' \times 8'.

The estimated cost of the Project is:—

Dam	Rs. 23,58,189
High level canal ...	6,02,457
Low „ „ ...	10,00,000
Compensation	1,11,000
	<hr/>
Total Rs.	40,71,646
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The value of the water stored is 3,850 c.ft. per rupee.

If the whole area for which there is water is irrigated

there would be—On the left bank	64,900 acres
On the right bank	75,000 „
	<hr/>
Total	140,500 acres,

which at the low rate of Rs. 3 per acre would give a revenue of Rs. 4,21,500 and a return of $10\frac{1}{4}$ per cent. on the outlay. The work for its financial success depends on a sufficient number of cultivators to make full use of the water. The land is there, and the water of this large river all now runs every year to waste, and is lost to Rajputana. Why should this be allowed to continue?

Perhaps objections may be made that this Project is too large, but no Irrigation Project can be considered thoroughly satisfactory which does not provide a Storage Reservoir with water sufficient to meet the requirements of bad years, and it would have been a matter of regret if this opportunity had not been taken of showing how it is possible to deal with a large river like the Banas, and even in Rajputana to make one of the finest Storage Reservoirs in India.

It may be possible, perhaps, to make a saving of about 5 lakhs of the outlay by omitting the automatic gates on the weir for the present, and putting them up when the demand for water is greater than the supply. All these and many other points are alluded to in the printed Report.

The lands affected by the Project belong to Mewar, Ajmer (Istimrari) and Jaipur, and perhaps Bundi and Tonk. It is impossible for the Native States to carry out such a large work, even if they combined; the help of the Imperial Government is needed, and without this help there is no hope of anything being done.

The admirable Report prepared by Mr. Manners Smith and his subordinates show how the Engineering difficulties may be overcome. The difficulties which have now to be met are Political and financial.

It is suggested, as the first step, that the Government of India be asked to send some special officer to report upon the Project as soon as possible, to see that the Project is really a sound one and can be carried out for the sum named. When this has been satisfactorily settled it will be time to consider the next step.

The Consulting Engineer has noted these difficulties, and invites consideration of the suggestions he has made.

It is impossible in a brief Note of this sort to enter into all the details of this grand Project, but in the printed Report will be found much of interest, and a reference to this is invited.

Since the above remarks were written, intimation has been received that the papers connected with this Project have been forwarded to the Government of India by the Hon'ble the A. G. G. for Rajputana, with "the sincere hope that so magnificent a scheme will receive very early sanction from the Government of India." (*Letter No. 1110-S, dated 27th March 1905, from the A. G. G. to the Secretary to the Government of India in the Foreign Department*).

Regarding Mewar generally the following suggestions were made:—

- (1) An Irrigation Department distinct from the ordinary Public Works Department.
- (2) To develop Irrigation from existing lakes and tanks and to make use of the water lying stored, wherever it is possible to do so.
- (3) To have all broken bunds repaired without delay, wherever water can be profitably stored; and, if necessary, supply cuts to be made from adjacent nullahs to fill them.

It was stated in the Note by the Consulting Engineer in 1903 that if this Durbar could be induced to take up good Irrigation Projects it might induce others to follow its example.

It is satisfactory to be able to state that since that Report was submitted H. H. the Maharana has decided:—

- (1) To create an Irrigation Department distinct from the ordinary P.W.D. One lakh of (Udaipuri) rupees will be set apart for this annually.
- (2) To call for reports on existing Irrigation Works, with a view to their further development.
- (3) To consider Projects for new Irrigation Works after investigation by the new Department.
- (4) To have detailed Surveys, Plans and Estimates prepared of the three large Projects suggested in the reconnaissance Report.*

*Mr. Manners Smith is now arranging for this on the spot.

His Highness the Maharana states that any suggestion for increasing Irrigation from existing works will be considered, and sanction given where necessary. The proposed Department is to draw up a programme of large and small works for famine purposes, and to prepare estimates of such works as will provide relief in time of famine and be of advantage to the State after completion.

His Highness alludes to the question of Jagir and says: "If it should be necessary to bring a Jagir village within such area, some Khalsa village should be given to the Jagirdar concerned in exchange for his village, the value of the village being reckoned at the amount admitted by the owner in Sambat 1907. It is hoped this will overcome this difficulty on this point." H. H. the Maharana concludes his letter to the Resident thus: "I also wish to state that Sir Swinton Jacob and Mr. Manners Smith have rendered great assistance to Mewar by their inspection of so many places in the State, and by their valuable report," showing that he appreciates the work.

To have been able to secure the interest and co-operation of H. H. the Maharana is a great point gained, and a matter of congratulation to all concerned.

PERTABGARH.

Pertabgarh.—This is one of the smaller States of Rajputana. It has an area of only about 886 square miles. The population is only about 52,000. The average area of Khalsa land irrigated is about 12,600 bighas, of which only 210 are from tanks ; the rest are from wells. Pertabgarh is the only town. There are only 412 villages, of which 303 are Khalsa; total land revenue is only Rs. 1,30,000 in normal years of rainfall. There are 31 tanks in the State; only 9 are used for Irrigation. There are no sluices, water is baled out by hand or drawn by bullock ; these are old works, and the best is said to irrigate only about 25 acres.

The work done in the recent famine was chiefly excavation in the bed of tanks, and naturally has not extended Irrigation, which is carried on at present entirely from wells and “odis” or half-open wells on the banks of nullahs.

The greater portion of the cultivable area of the State is composed of rich black soil which does not require irrigation. The crops simply depend upon the winter rain ; if this is timely and good an abundant harvest follows.

Grass in ordinary years is everywhere plentiful, and is sometimes left standing for want of men to cut it. Wells and “odis” are the mainstay of the people ; they can be easily made without professional aid, and in time of scarcity, if properly made, do not fail.

The population is so sparse that wells will probably be sufficient to meet the needs of all, except the Bhil population, for a long time to come.

Attention is invited to paras. 15 to 19 of the Report by the Superintending Engineer.

The opinion of the local authorities is, that the proper way of ensuring against years of drought is to increase the number of wells. Since the State has enjoyed a long immunity from deficient rainfall, large Irrigation Schemes have not been considered ; the people have more faith in wells, which are more practicable, and do not cost so much as in many other parts of Rajputana ; and this appears to be sound.

About 900 or nearly half the present number of wells require deepening and repairs ; many will, sooner or later, fail if not attended to promptly. Many cultivators complain of the heavy burden of annually clearing and maintaining the present kutchha wells.

Taking into consideration these facts, the conclusions arrived at regarding the Pertabgarh State are :—

- (1) That at present large Storage Reservoirs are not necessary.
- (2) That wells and “odis” or half-open wells are necessary, and should be improved and the number increased ; that this policy should be steadily maintained until every existing well is in a satisfactory state. Nearly half the present number of wells require deepening and repairs (Superintending Engineer’s Report, para. 18).
- (3) That on every nullah where possible small weirs be made to hold up some water ; and half-open wells or “odis” be made on the banks to use the water for irrigation (Superintending Engineer’s Report, para. 19).
- (4) It is advisable to have Plans and Estimates of two or three large and useful Irrigation Projects prepared so as to be ready to meet seasons of distress. These have been drawn up under Mr. Manners Smith’s supervision, and are all described in the printed Report on Irrigation in this State.
- (5) The greatest difficulty, however, is financial.

“In a State financially sound there would be no difficulty in carrying out the proposals suggested, but Pertabgarh is now (1904) over six lakhs in debt, and there seems little prospect of anything being done systematically, unless Government comes to its assistance.

“If a loan on easy terms could be obtained for the improvement of Irrigation Works, the wells should first be put into thorough order, and then the State would be well protected against famine. The work is what the people could carry out themselves ; it would be distributed, and all the money would be spent in the State itself.

“Pertabgarh possesses natural advantages for cultivation : it only requires money to carry out what has been suggested, and cultivators to make full use of the improvements to become prosperous.

“When the Revenue Settlement now in progress is completed and in working order it should give security to the agricultural class, and with good administration, cultivators from outside should be attracted to the State.

“New wells could then be sunk, more land would be irrigated, the revenue would increase, and the State should, in consequence, make great progress.”

“A bold and liberal policy is necessary, and a lively interest in the subject by those in authority ; but without this and some help as suggested there appears to be little hope of any real improvement.

Some arrangement seems advisable to ensure proper supervision, if any work is started. (See concluding remarks on the Note on Irrigation in the Pertabgarh State by the Consulting Engineer, paras. 7 and 8).

S I R O H I .

Sirohi.—(1) The villages are nearly all situated on the banks of the many nullahs in the State, and the wells are similarly situated, and consequently seldom run dry. The country is adapted for well-irrigation, as owing to these nullahs water is fairly near the surface, while the country is broken up with a limited area of culturable land.

- (2) It is recommended, as the best protective measure, to deepen all those wells in which the water is insufficient ; and wherever more land can be taken up and there is a demand for sinking fresh wells, funds be advanced for this purpose.

Wells have this advantage that they are not absolutely dependent on the rainfall but are supplied from natural springs.

- (3) Nearly all the Irrigation in the State at present is from wells. The value and importance of wells was proved in the last famine and cannot be over-rated.

The remarks made by the Superintending Engineer in paras. 15 to 17 of his Report, page 3, are deserving of attention.

- (4) Large Storage Reservoirs, when properly carried out, are of great benefit to a State, but it is well to remember that the resources of the Sirohi State are limited ; that the villages are few and far between ; that at present it is doubtful if there are people ready to cultivate more land than is at present cultivated ; that some storage tanks which have been made of late years have not been a success ; that there is uncertainty sometimes whether water, if stored, will not disappear in the soil. Large works, moreover, take a long time to carry out, and a longer time before the benefits can be fully realised ; and if carried out with borrowed money, often, for a time at least, add to the financial burden of the State.

- (5) While, therefore, endeavours have been made to find sites for large Storage Reservoirs, and to suggest works of greater scope than the people themselves could initiate, it was felt that all the above points demand consideration and caution.

- (6) At the same time, looking at the map of the State, it will be seen how many nullahs there are, and how they are distri-

buted naturally over the whole State ; and that nearly every village is commanded by some nullah on higher ground, and what a large quantity of water must run annually to waste. Owing to the rocky nature of much of the country and the slope it is evident a large portion of any rainfall must pass rapidly away, hence the need to prevent this.

- (7) If there are people ready to make use of the water why should not a large portion, if not all of it, be diverted by weirs or cuts from the nearest nullah on to the waste lands which surround almost every village ?
 - (8) Why should not the water be stored here and there, in long shallow earthen bunds, from which in due season it might be let out to the fields below, and the beds of these tanks then be cultivated ? The Sukri River affords a good opportunity. (See pages 5 and 30 of the printed Report on Irrigation in this State).
 - (9) Why should existing tanks in any village remain unfilled when nullahs near them flow away to the sea ?
 - (10) In paras. 30 and 31 of his Report on the Sirohi State the Superintending Engineer has stated the procedure recommended. It is unnecessary to repeat it here, but attention is invited to this system, as it appears to be most suitable to the conditions of this State.
 - (11) For every village wherever the need or possibility exists, Projects with estimates should be prepared, levels be marked, and permanent bench marks be put up, so that the work could be started at any time.
 - (12) The only expenditure which need be incurred at present is the establishment necessary to do this preliminary work.
 - (13) Attention is invited also to para. 64 of the Superintending Engineer's Report in which the result of his investigation in the Sirohi State is summed up, and the Note by the Consulting Engineer for Irrigation, of which the above are brief extracts.
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Tonk.—The Tonk State consists of six separate Parganahs:—

Three in Rajputana, *viz.*, Tonk, Aligarh, Nimbahera.

Three in Central India, *viz.*, Chabra, Sironj, Pirawa.

After the visit of the Irrigation Commission to Rajputana, on their recommendation a grant was sanctioned by Government for the preparation of certain Projects suggested as worth investigation. This work was undertaken by Mr. Wakefield, an Engineer Officer who was then Superintendent of Revenue in the Tonk State. His Note on the work done and Projects prepared is printed and attached as Appendix I to the "Report on Irrigation in the Tonk State," submitted by Mr. Manners Smith, Superintending Engineer.

This Report relates to the three Parganahs in Rajputana only, and was submitted after he had completed his investigations. It deals with the whole subject, and is clear and comprehensive.

The following is a brief summary only:—

Tonk Parganah.—Average rainfall 18·68," minimum 9·20." Area—Khalsa, 178,506; Jagir, 182,997; total area, 361,503 acres; of this 12,915 acres are irrigated and 73,560 unirrigated.

There are 150 tanks in Khalsa, of which only 43 are used for irrigation. There are 2,542 Khalsa wells irrigating 11,715 acres, or 4·6 acres per well, but in the famine year 1901-1902 this fell to 6,957 acres, or 2·6 acres per well.

With the exception of the tank at Chanlai, constructed by Mr. Wakefield, none of the water that passes down the nullahs has been utilised.

It does not seem to be possible at present to do anything with the two large rivers, the Banas and the Mashi, which are met with in this Parganah.

Aligarh Parganah consists of undulating country intersected by nullahs. Of the total area of 100,123 acres, 40,621 are Khalsa and 59,502 are Jagir; of Khalsa land 1,957 are irrigated and 17,550 unirrigated.

There are 48 Khalsa tanks and 439 wells in Khalsa land, which irrigate 1,801 acres, a little over 4 acres per well. Since the famine the water level in the wells has fallen considerably. Near Aligarh itself, of the 80 wells belonging to the village, only 20 are now said to be in use.

The assessment for irrigated land varies from Rs. 2-4 to Rs. 5-11, and from unirrigated from Re. 1-2 down to annas 3.

There are sites on nearly all the nullahs where storage tanks could no doubt be made; and the reason perhaps why advantage has not been taken of them is because the northern portion of this Parganah with its "mal" land produces good crops without irrigation.

The opinion, too, prevails that owing to the slate rock with vertical fissures, especially in the southern portion, tanks even if constructed will not retain water.

Tanks, however, which had been made at Patoli and Soulatpura by Jagirdars were a success.

The Superintending Engineer states that the dams of the few tanks he saw in the southern portion were breached, and had not been repaired, for the reason given that any water stored quickly disappeared through the rock below. In such places he recommends masonry core-wells; perhaps grouting all the fissures above and below near the site of the nullah crossing might help.

Even should the tanks leak, the beds, many of which are now broken ground, would be reclaimed, and the water level in the wells below would be raised; at all events one or two might be tried.

The Superintending Engineer (Mr. Manners Smith) thoroughly investigated this Parganah. Of the nine Projects suggested, all but one are in Khalsa land. Plans and Estimates will be submitted for the Durbar's consideration, and if the conclusions noted in para. 34 of his Report are found, when one or two works have been carried out, to be correct, there will be plenty of work to be done.

Nimbahera Parganah.—The area is 247,727 acres, of which 163,405 are Khalsa and 84,322 are Jagir. There are 3,906 wells in the Khalsa area, which irrigate 12,649 acres, and this gives an average of 3·2 acres per well. During the famine the wells only irrigated 3,470 acres, less than one acre each.

There are 15 Khalsa tanks, but with the exception of Uncha, which was constructed last famine, under the directions of Mr. Wakefield, all are small, and several need repairs.

New Projects have been proposed by the Superintending Engineer, and are described in his Report. The need for protective measures seems great, for many villages are now deserted, and owing to the heavy loss (about 37½ per cent. of the population) after the recent famine, large areas of land are lying idle for want of cultivators.

The remarks at the close of Mr. Wakefield's Report deserve notice. He says: "I cannot do better than again emphasize the vital importance

of Irrigation to the Tonk State. Such very good opportunities exist that it is culpable to neglect them. During the past two years a beginning has been made, and the State is already reaping the benefit, but very much more remains to be done. The natural resources of the State remain practically untapped, and although the State is financially embarrassed it would pay to borrow money to arrest the wealth which yearly flows to waste to the sea."

The Consulting Engineer visited those places on which his opinion was desired, and his Notes on each will be found in the Report by the Superintending Engineer.

The Tonk State has many places for storing water : the soil is generally very good. Small tanks are met with at almost every village, but many are not kept in a proper state of repair ; surface or nullah drainage is not taken full advantage of ; the earthwork is not level, and the escapes sometimes not kept up to the mark.

The resources of the State are limited, and at present the State is in debt ; so that it is not advisable to suggest many large Projects just now.

The following points, however, are suggested (see page 19):—

- (1) The preparation of a statement showing all existing tanks, whether Khalsa or Jagir ; the condition in which they now are ; and what steps if any are necessary to make them efficient.
- (2) The preparation of estimates for each work that needs repair, with the opinion of the Revenue officials.

It is of the first importance to have all existing works put in a proper condition. No money can be spent in a better way. Where there is a real interest in Irrigation this will be the first step in the right direction.

A reference to the Report on Irrigation in the Tonk State which has been prepared and submitted by the Superintending Engineer (Mr. Manners Smith) will show in detail each Project proposed, and the suggestions offered to promote Irrigation.

CHIEFSHIP OF SHAHPURA.

Chiefship of Shahpura.—The Shahpura Chiefship has an area of 405 square miles only. The country is flat, the soil mostly clay and sand. The population is only 43,000.

There are 210 villages, of which 103 are Khalsa and 72 Jagir. The average rainfall is 24 inches. The personal interest shown by the Raja Dhiraj Nahar Singh of Shahpura in Irrigation deserves encouragement. He has had sections taken all over his Chiefship to determine the reduced levels at different places, which will be found useful for Irrigation, and he goes personally to see places and to judge for himself, and during the last few years he has spent about Rs. 15,000 annually on Irrigation.

As the country slopes uniformly from west to east, it is well suited for Irrigation. There are 6,655 wells, kutchha and pucca.

The existing 170 tanks are mostly small earthen bunds, but are not sufficient to protect the country in years of scanty rainfall. Large quantities of water flow through in the rains and go to waste, while the country is in urgent need of water.

Projects on which the advice of the Consulting Engineer was desired were inspected in 1903, and a Note was submitted on each by him. The Plan and Estimates of those which were approved and the suggestions made have been carried out, printed, and placed on record by Mr. Manners Smith, and show what can be done.

The resources of the Chiefship, however, are not sufficient to meet the cost of any large Project. The Chief is hopeful (and is not the only one, from the interest the Government of India has shown in Irrigation and in the welfare of Rajputana) that means will be found to afford financial help to carry out some at least of the Projects recommended. This is a matter which no doubt the Political Officers will represent, as some help of this kind is necessary if any progress is to be made.

It is deserving of note that in one Project (Dikola) estimated originally to cost Rs. 2,38,924, the suggestions made by the Consulting Engineer have resulted in a revised Project, by which this large outlay has been reduced to Rs. 1,34,056. This includes Rs. 60,410 for strengthening and raising existing tanks which the original estimate did not include. Thus —

(1)	Head works and Channel with escape and supply cuts	...	...	...	...	Rs. 73,646
(2)	Strengthening and raising existing tanks				„	60,410
	Total	...				Rs. 1,34,056

This gives a saving of Rs. 1,04,868.

The original scheme would have submerged some well land, and would have cut off some water from existing tanks. The revised Project secures every drop of water, submerges no well land, and by a canal on the contour leads all the water to existing tanks, which can be raised, and after filling them each in succession, ends in the large tanks at the town of Shahpura, nine miles distant, where water is much needed.

The printed Reports which have been submitted show what is proposed. There is no doubt if these Projects are properly carried out, and advantage is taken of the water, the benefit to the people and to the Chiefship will be considerable.

ISTIMRARI ESTATES OF THE AJMER DISTRICT.

Istimrari Estates of the Ajmer District.—The Superintending Engineer (Mr. Manners Smith) has carefully inspected the whole of these Estates and has submitted a good report, which shows that the Istimrars thoroughly appreciate the value of storage tanks and Irrigation, and (mainly owing to the influence of the late Colonel Dixon) all have carried out works to the best of their ability for the benefit of their Estates ; in fact nearly all that is possible has been done, and the number of new Projects is limited.

The division of the district into petty Estates does not contribute to the best distribution of water. Each owner thinks only of his own interests, and makes any new proposals very difficult. In 1903 the Consulting Engineer submitted a memorandum making certain suggestions. Among these he pointed out that “ if storage on the nullahs cannot be made without infringing the rights of others, it might be possible perhaps to take off a good cut or canal high up, so as to secure a large portion of the water which now goes to waste and divert it on to high ground, where it can flow over the country and benefit many instead of a few, by supplying water to every tank in turn below. Some scheme of this sort appears to be the only way of meeting the difficulties peculiar to the Ajmer district.”

Among the Projects taken up by Mr. Manners Smith and fully described in his Report there is one of some interest, namely, the Khari River Project ; because after much inquiry and correspondence regarding a canal from the site selected for a weir across the river at the village of Garur, in Mewar, it was decided by the Chief Commissioner in August 1877 that the Project was impracticable.

It appeared, however, to the Consulting Engineer for Irrigation that although the construction of a permanent weir at Garur had to be abandoned, still it might be possible to do something with this large river, by taking a large cut from it, starting flush with the bed of the river, so as to ensure part of the flood which now goes to waste reaching ground where it might be stored either in existing or proposed tanks lower down, doing in fact on a large scale what the Rao of Masuda had already done at this place in a small way for his own benefit, to supply water to two or three of his tanks distant about three miles from the river.

Surveys were accordingly made and a cut was found to be possible. A Project has been prepared and printed and placed on record by the Superintending Engineer (Mr. Manners Smith).

On the Khari a groin would be constructed, with massive blocks of concrete boulders to divert a portion of the floods down the canal, and the remainder would pass on as usual down the river for the benefit of percolation to the wells on either side of the river below, thus saving the cost of a pucca weir across the river, about Rs. 75,000, and meeting the objections made against a pucca weir. The canal line at present has only been surveyed for 20 miles, but as the country slopes uniformly in this direction, it can be continued further if desired. It would intercept all cross drainage and lead it to be stored in tanks below. The following existing tanks would be commanded on the way and could be supplied from the canal—(1) Kesarpura, (2) Lodiana, (3) Satana, (4) Sakrana, (5) Burli.

New tanks could be constructed at (1) Khoontia, two tanks; (2) Lodiana; and (3) Satana.

If the canal was made 30 ft. wide at first and 3 ft. deep it would cost about Rs. 1,800 per mile, and including masonry work for overflows, inlets and nullah crossings would cost about Rs. 55,000 for the first 20 miles. It could be widened at any time. There is no doubt that such a Project would be of great protective value to the Ajmer district. Even in famine years this river runs for a short time, and with the intercepted cross drainage would be sufficient, probably, to insure the filling of the tanks commanded, and to save the crops they irrigate. This ought to make it acceptable to the Istimrardars through whose lands it would be taken. It would be an admirable relief work should the need arise; the work could be easily checked, and would be spread over a large area.

It is impossible in a brief review like this to describe all that has been done or suggested; but the list of Projects which have been surveyed in the Istimrari area, and for which Plans and Estimates have been or are being prepared, under Mr. Manners Smith's supervision, is shown in Appendix E—16 Projects in all.

The following remarks by Mr. Manners Smith are deserving of consideration (paras. 48 and 49 of his printed Report):—

“Though there is very little left in the way of new works, it is most important, considering how much has been spent (see para 6), that the existing tanks and Irrigation Works on which the revenue of the Istimrardars chiefly depends, should be kept in proper repair, and that all improvements should be carried out at the least cost and to the best advantage. This can only be done by professional assistance and supervision, and at present the Istimrardars have to pay for any help of this kind, all works on which the advice of the Executive Engineer, Ajmer Provincial Division, is given being treated as ‘contributional,’ and large percentage charges for establishment being levied. As the majority of the Istimrardars are poor and in debt, this prevents assistance being asked for, with the result, espec-

ially in famine time, when they are obliged to afford relief to their tenants, that works are opened without Surveys, Plans, and Estimates, and repairs executed without system and professional supervision. In consequence, money, most of which has been borrowed for the purpose, is wasted.

“My inspection showed that repairs are needed to a very large number of the existing tanks, as nearly all are weak in section, and liable to break at any time; in fact in the majority of cases it would appear that repairs are deferred till a break occurs.

“I would recommend that Government be asked to assist the Istimrardars by giving them professional advice and assistance free, and by offering loans to those requiring it, on lenient terms, to induce them to put all their tanks into thorough order.

“For supervision this would mean a competent Irrigation subordinate attached to the Ajmer Provincial Division, in addition to the existing establishment. He would then be directly under the orders of the Commissioner and Executive Engineer, solely for employment in the Istimrari area.

“He would work out any new Projects or improvements the Istimrardars might suggest, and which were approved after inspection by the Executive Engineer, and he would tour round inspecting and seeing that repairs were properly executed and improvements scientifically carried out.

“In this proposal there is no wish to interfere with the rights of the Istimrardars, but to help them. The execution of work and repairs and payment for same should be left entirely to the landlords themselves, on the understanding that the instructions of the Executive Engineer, as supervised by the Sub-overseer, were followed.

“By this means it is hoped useless Projects would be avoided and money saved, and what work was done would be properly done; and in the course of time there should be a general improvement in the tanks and system of Irrigation from them, tending to a better use of the water and an increase of land irrigated, with its consequent increase of revenue and profit to the estate holders.”

In any case it is most important not to do anything that will increase taxation, or give the idea that Government wish to force supervision or to interfere. Whatever is done should be done in consultation with, and with the co-operation of, those concerned.
